

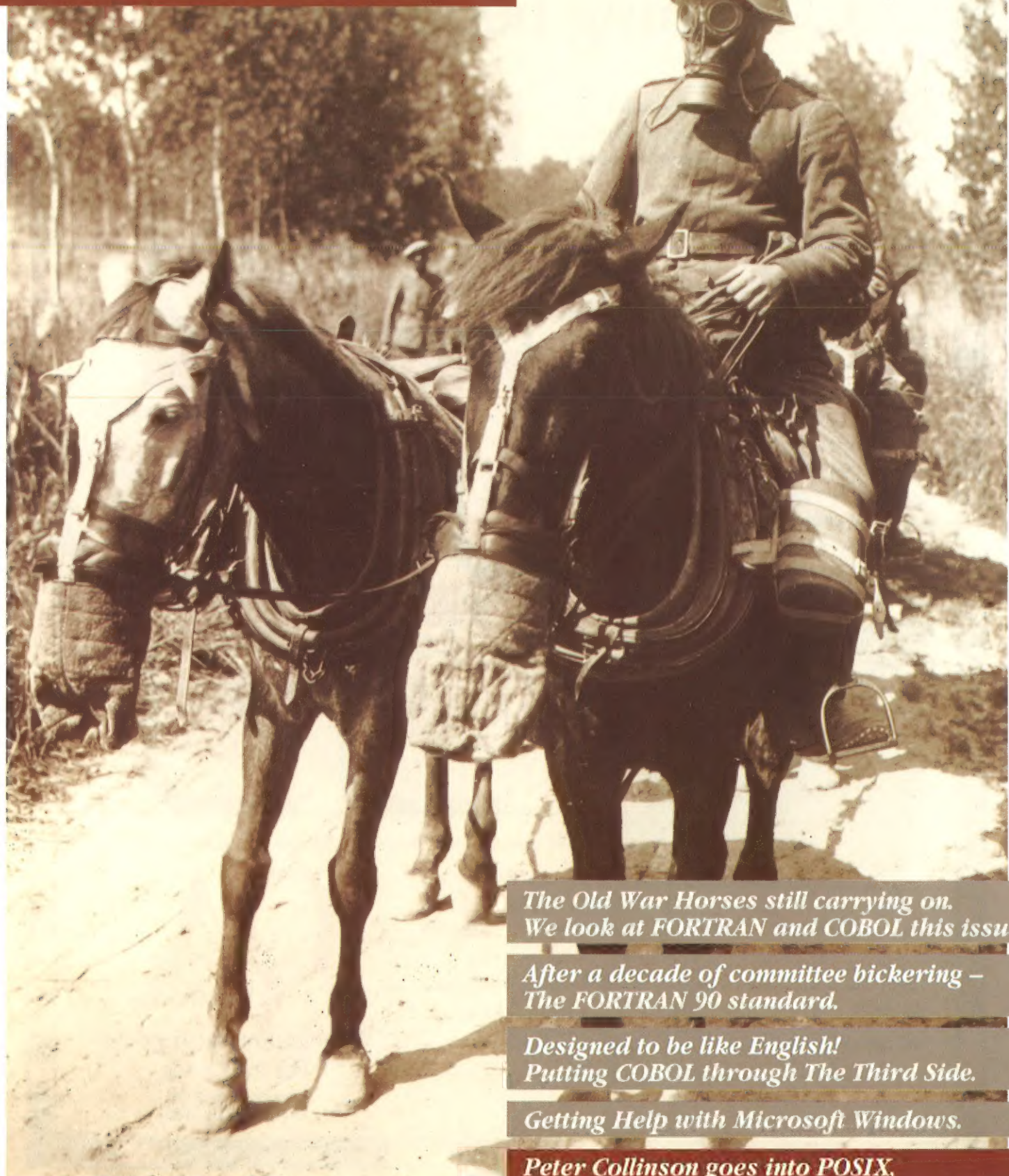
EXE

AUGUST 1991

VOL 6

ISSUE 3

Eight GUI Libraries
for C & C++



*The Old War Horses still carrying on.
We look at FORTRAN and COBOL this issue.*

*After a decade of committee bickering –
The FORTRAN 90 standard.*

*Designed to be like English!
Putting COBOL through The Third Side.*

Getting Help with Microsoft Windows.

*Peter Collinson goes into POSIX,
Jules May goes into Hyperspace.*

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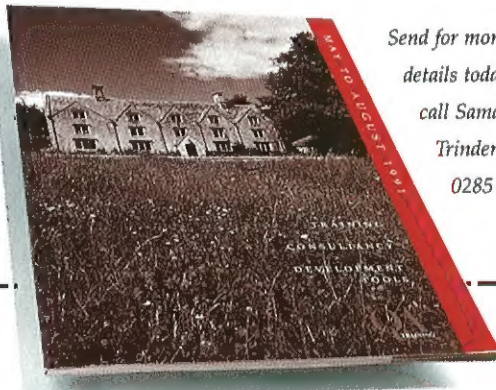
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Issue theme: FORTRAN and COBOL

FORTRAN 90, THE NEW FORTRAN STANDARD

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O-O environments, not languages

To get the real benefits from OOP, you require more than just a language, argues Nick Evans.

Two technologies are indisputably in fashion this year. One is GUIs. The other is object-oriented programming and development. The two are linked - the reason OOP is becoming so popular is that it is much more productive than C for development under platforms such as Windows, PM and OSF/Motif.

Of all the OOP languages available, the most popular is C++. Due to the increasing popularity of the object-oriented paradigm for development and C++ in particular there is a danger that the two will be seen as identical - that to use object-oriented techniques means to use C++. This is not the case. In fact many of the productivity benefits of using OOP for GUI development are more to do with the environment provided by the language than the syntax.

Not all OOPLs are the same. Let us consider the case of Windows development. There are many OOPLs around now for Windows; for example C++, Actor, Object\1, Enfin and Smalltalk. Let's compare these with the traditional system of Windows development: Microsoft C.

All of these have some form of symbolic debugger. Both C and Glocksenspiel C++ use Microsoft CodeView; Actor and Smalltalk have their own debuggers within the environment. The point about CodeView is that it is not integrated with the language used. In Actor or Smalltalk, an error will automatically cause the debugger to be invoked (in the development system). The programmer can then examine any variable, update the database, amend the code and finally resume the application. This makes for a very fast iteration indeed - something that cannot be matched by a system without an integrated debugger.

Incremental compilation is another important point. None of the environments mentioned is interpreted - Actor uses token threading (c/f FORTH), while Smalltalk compiles methods down to an executable. However, in all cases the environment gets away from the traditional code-compile-run cycle, with the tool accepting changes either as they are made and compiling them as they are accepted or when they are next run. Whichever the approach, the system is never compiling more than a page or two of code - so that the time taken to accept changes is rarely more than five seconds.

One important point about environments is that they often perform automatic memory management for the developer. This means that the programmer need never use the `alloc()` and `free()` functions again - the environment reuses space as and when variables are no longer referred to by objects within the system.

Development speed, something of a moot point this - just how much a given object-oriented tool reduces development time depends on which vendor you are speaking to. At my company we have used Actor, Smalltalk, C++ and C on a number of developments and are independent of all of them. This makes us well-placed to compare the development time and resource required to build systems in each of these languages.

It has been our experience that, of the four tools mentioned, Smalltalk/V Windows is the most productive, followed by Actor. C++ is some way behind both of them (although more efficient in terms of execution speed), while C itself is the slowest.

Each of these points boost productivity significantly. The point for us is that development in C++ is significantly faster than C alone, but nowhere near as productive as a full environment. This point is not lost on the vendors of C++ compilers - Borland has recently released a version of C++ surrounded by a sophisticated development environment, Microsoft is promising a class library to support its own C++ compiler shortly after it (eventually) arrives.

The fact is that a language like C++ will always be slower to use for development than a fully supported development environment. In return for this overhead on development, we receive a faster, smaller and more efficient runtime. So the question that has to be asked is: at a time when hardware cost is falling and performance increasing, does it really matter whether a menu

pops up in 10 nanoseconds or 60? And the answer must be no - not for the majority of applications.

At a time when developers are switching in droves to use C++, it may be unpopular to point out that there are other, more efficient, ways to build Windows systems. Nevertheless, if you are someone who pays for development, or someone who is responsible for the delivery of Windows apps in short time-scales, then the use of object-oriented environments rather than simply languages may be worth a look. After all, what matters is not how purely a language matches some arbitrary criteria of OOPness - rather how it can help do a particular job.

EXE



Nick Evans spent many years as a consultant in IT before he saw the light and co-founded Information Systems Associates to build systems for people. For the last 3 years ISA (081 840 3422) have been using OOP techniques and languages to deliver Windows and PM systems.

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BRIEFor C++

Yes, it's a poxy name isn't it, but it looks quite nifty. BRIEFor C++ works with the BRIEF 3.1 editor to provide a class browser for C++ programmers. Features include facilities to report on class hierarchies, member functions and variables, and associated implementation files. BRIEFor C++ for DOS or OS/2 is on special offer at £99 until the end of August and requires a copy of BRIEF 3.1. It is available from Solution Systems on 0763 244141.

New Motif GUI Tool

Protek has announced UK availability of the UIM/X interface generator for the Motif/X Windows environment. Up to now, the product has only been available in the States. In addition to the standard set of GUI tools, UIM/X also contains a C interpreter which allows the behaviour of the user interface to be created, modified, and tested at design time (without recompilation). Prices start at £3,125 for a single-user licence. Protek is on 0895 446000.

Derive V2.0

'2000 years of mathematical knowledge on a disk' it says here. Version 2.0 of the maths program contains extras such as recursion, iteration and a programming language. The package takes a non-numeric rule-based approach to problem solving which is claimed to be more accurate than other stats packages and equation solvers. Derive 2.0 runs under DOS and costs £130 from Chartwell-Bratt on 081 4671956.

X terminal for Microsoft Windows

XVision V4.0 allows a PC running Microsoft Windows to function as an X terminal without leaving the PC environment. A network of PCs using the TCP/IP protocol may be connected to any number of UNIX or non-UNIX hosts to enable the displaying of multiple X applications together with local Windows applications. XVision costs £399. Contact VisionWare on 0532 788858 for more information.

Spiritual Healing

A new software testing tool called Ghost from Vermont Creative Software enables developers to carry out comprehensive regression testing quickly and easily. Because it traps and records keystrokes at the DOS interrupt level, it is independent of the language used to create the executable. Ghost costs £99 and is available from The Software Construction Company on 0763 244114.



Borland swallows Ashton-Tate

In a move that has shocked the software world, US giant Borland International has announced that it is to acquire Ashton-Tate, manufacturer of the dBASE range of languages. At a joint press Borland/A-T press conference, Borland chief (and jazz flute-player) Philippe Kahn explained that, following three weeks frenzied negotiations, a deal had been reached by which A-T would become a wholly-owned subsidiary of Borland.

Borland also demonstrated two forthcoming products, tentatively scheduled for release in Q1 of 1992. Paradox for Windows will continue the expansion of the company's range of Paradox-compatible utilities, which already includes the Quattro Pro spreadsheet, the Sidekick desktop program and the Paradox engine. Object-orientation will be a major feature of Paradox for Windows with developers able to attach methods (implemented in PAL) to form objects, such as buttons. Object dBASE (formerly referred to as 'Turbo xBASE'), first mentioned in June's .EXE, will be a full MS-DOS and Windows development system. The product will run under Windows and incorporate a compiler and interpreter capable of producing executables for both the MS-DOS and Windows target environments. Language extensions to support Windows will be added but the compiler should be compatible with dBASE III and IV code. A fully integrated debugger will also be included.

Paradox for Windows and Object dBASE will continue to be developed in parallel and no attempt will be made in the near future to merge the two products. Speaking with regard to the dBASE and PAL languages, Borland's senior vice president, Richard Schwartz, drew the analogy between C and Pascal, saying that users should be able to choose whichever language was appropriate to their business needs. However, in accordance with Borland's commitment to interconnectivity, both file formats will be supported in each environment.

In the meantime, the future for Ashton-Tate and its product line is not altogether grim. Philippe Kahn gave assurances that the dBASE line will continue to be developed (see elsewhere in this news section for details of recent ports; also planned is a dBASE compiler, which is currently under beta-test) he dodged the question when directly asked if there would be a dBASE V. It seems likely that dBASE development as such will be wound down in favour of Object dBASE. Users will be presumably encouraged to migrate from dBASE to Borland's Windows product. It has been stated that development and support will also continue for A-T's Applause, MultiMate and Framework product lines. Most interesting is the placement of A-T's Interbase 'object' Server in Borland's strategy. The product is a multimedia, object-oriented database server. Interbase was acquired by Ashton-Tate just three months ago and is integral to Borland's vision of the future. It all looks a little too convenient not to have had some element of pre-planning. A-T's fortunes have never fully recovered from the release of the disastrous, buggy dBASE IV 1.0. Last year, A-T achieved about the same turnover with 1,700 employees as Borland did with 1,000, so A-T redundancies would seem inevitable.

Commenting on the news, George Fletcher, MD of Nantucket UK, said 'Our first reaction was that Borland had bought an expensive mailing list. However, it looks to us that Object dBASE might be the first real competition to the Clipper development path.' He admitted that it would be 'a while' before Clipper Windows would appear.

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EXPERT for 68040

ACE Associated Computer Experts has added a new member to its **EXPERT** range of optimising compilers. This is a new 68040 code generator that is available for C, Fortran-77, Pascal and Modula-2. The combination of an optimising compiler with the lightning speed of the 68040 certainly adds fire to the RISC/CISC debate. The compiler costs 4800 guilders. ACE may be reached on 01031 20 6646416.

Profile Editor for OS/2

This new utility enables developers to access and modify information stored in a user, system or private profile. The editor displays a list of all the application names found on the current profile and displays the data associated with a selection. The Profile Editor costs £70+VAT to OS/2 User Group members and £100+VAT to non-members. Contact OS/2 UG on 0285 655888.

ZipitUP

This catchy product name applies to the reincarnation of a deceased piece of software called Minder. The revamped application is a software protection system that prevents illicit copying of DOS executables. Protection is made with the Core Utilities onto ZipitUP Key Disks. These have a standard DOS format plus an invisible 'lock' and are purchased from the company. ZipitUP Core Utilities cost £99.95 (but you can get an evaluation pack for £25 incl VAT and postage). It is available from Data Business on 0865 842224.

Anti-viral artillery

A new version of Dr Solomon's virus zapping toolkit (V5.0) has been released by S&S International. VirusGuard is a TSR that warns a user if an attempt is made to manipulate an infected file. CheckVirus is a utility which traps a file that has been maliciously modified by recording its checksum. There is also a FindVirus tool which can identify a given virus. The Anti-Virus Toolkit costs £59 and is available from S&S International on 081 6912735.

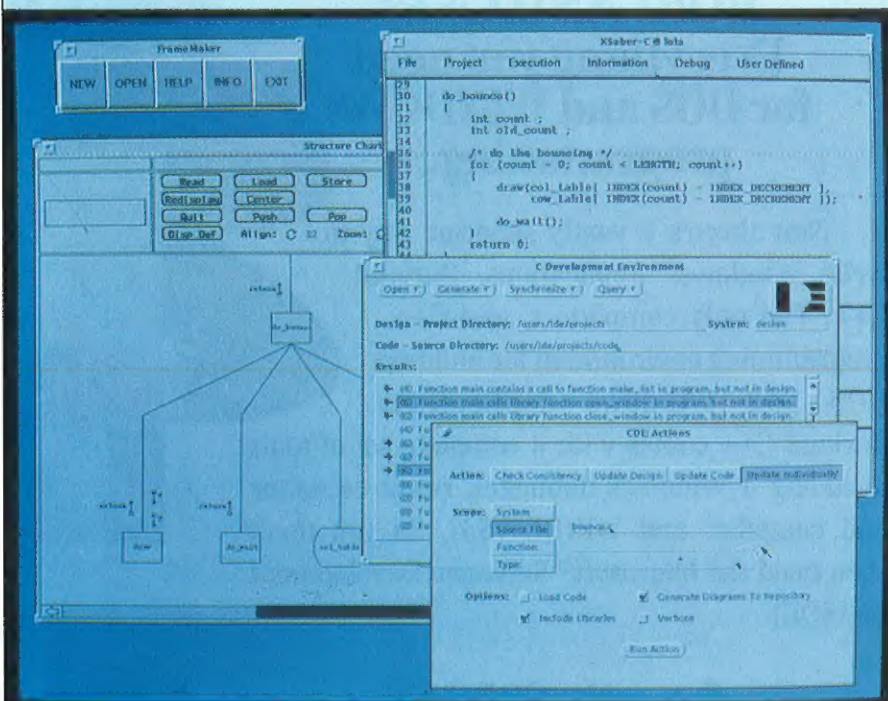
New and Improved FASTBACK

Fastback Plus V3.0 is Riva's latest release of its back-up utility program. Speed of backups and restores has now increased and there is also a 15% higher level of data compression than on the previous version. A scheduler and macro recorder enables fully automated backing up. Fastback Plus V3.0 costs £145. For more information contact RIVA Ltd on 0420 22666.

State-of-the-Art C Development

Interactive Development Environments (IDE) has announced its C Development Environment (which I shall refer to as CDE, since the company has neglected to provide an abbreviation). CDE is a tasty casserole of exotic tools for developing C software on UNIX workstations and servers. IDE's CASE tool, Software through Pictures, is integrated with the Saber-C compiler/debugger and the FrameMaker or Interleaf publishers (see pickie). Features include reverse engineering and code generation modules, facilities to synchronise code and designs, query the shared repository, and navigate among the components. CDE is designed to be beneficial even if introduced half-way through a project. The company also believes that most developers do not adhere rigidly to formal software engineering methods, so CDE does not impose any. But IDE reckons that because everything is so integrated, it will encourage people to use its CASE technology.

The C Development Environment is available from August 1 on Sun SPARCstations. IDE flatly refuses to give us any indication of how much the thing costs. Phone IDE on 0483 579000 (and see how far you get).



Clever Debugger

Convex Computer, formed in 1982 and which previously specialised in complete solutions in the supercomputing market, is now offering a source-level debugging tool that has the ability to analyse even highly optimised code. A windowing environment allows simultaneous viewing of the source code, assembler and program output. Convex is claiming that its CXdb tool is more efficient at pin-pointing complicated programming problems than other, more orthodox, debugging tools. CXdb costs £3500 and is distributed in the UK by Convex Computer Ltd on 0372 386696.

10BASE-T Networks

3Com has released a new modular hub to allow cheaper expansion of 10BASE-T networks. The MultiConnect TP Starter kit has 12 ports and can take a maximum 15 expansion modules, enabling a user to have up to 45 ports in total. Each module

contains a number of LEDs which can be used to trap faults. An abundance of networking media are supported, including thick and thin Ethernet and twisted-pair cabling. The MultiConnect TP Starter Kit costs £1185 with each additional 3Comm TP Module costing £395. 3Comm can be reached on 0628 890670.

A CASE for better productivity

SE/Workplace is a Windows-based tool that provides links for the LBMS Systems Engineer CASE family into desktop applications such as word processors, spreadsheets and E-mail. It uses Dynamic Data Exchange (DDE) to transfer data from one application to another in real time without user intervention. This permits the criteria of a given query, on the Systems Engineer database, to be embedded into the selection process of any other application using the database. SE/Workplace runs under a Windows or a DOS 386/486 environment and costs £1500. It is distributed in the UK by LBMS on 071 6364213.

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Lend Me Your Ears

Talking computers are nothing new, but Monologue V2.0 from First Byte seems very easy to use. Without any special hardware requirements, Monologue will speak text in a document or on the screen using the PC's own built-in speaker.

It uses a sophisticated set of phonetic translation and pronunciation rules to synthesise speech, including stress patterns (ie it doesn't drone on in a monotone). The program loads as a TSR which is activated by a hot-key combination in your editor, spreadsheet, database etc. Once you've highlighted some text you just hit RETURN and Monologue starts reciting the thing. I'll admit that it doesn't have quite the earthy resonance and crystal clarity of John Gielgud, but it ain't bad. Apparently some PCs have much better voices than others (mine was embarrassingly poor and has promised to give up smoking), so you can get various hardware add-ons to boost their performance.

There is also a toolkit available for First Byte's SmoothTalker speech driver, with an API so you can write talking DOS programs. Languages supported are C, Pascal, QuickBASIC and assembler. In addition, a character-oriented device driver is included. This may be used by any application which allows macros or languages to write to an external device (eg Lotus 1-2-3, Quattro, dBASE, Foxbase, Clipper etc).

Monologue V2.0 is priced at £89 and The Speech Toolkit retails at £395. Both products are available from Iansyst Ltd tel: 071 6075844

Microsoft Visual Basic Ships

Microsoft Visual Basic Programming System for Windows (see .EXE June '91) is now in the shops. The product is a Windows 3.0 development tool which comprises a GUI screen designer and a general purpose programming language. You simply design your front-end with the interface builder (no code necessary) and then implement event procedures in the VB language.

The VB language is a mutant offspring of Microsoft QuickBASIC, with some correc-

tive surgery to enable it to handle the event-driven graphical environment. It uses a threaded p-code incremental compiler and comes with a source-level debugger. This allows users to create compiled Windows .EXEs that can be distributed freely without any run-time fees or royalties. Support is provided for DDE and you can extend the control set using Microsoft C, the Windows SDK and the VB Control Development Kit (available separately).

Hot on the heels of VB's arrival comes the announcement of the Visual Basic Library and SDK for Microsoft SQL Server. This adds VB to the list of languages from which the SQL Server API (DB-Library) can be called. So prospective VB programmers can access SQL Server and DB2 on the mainframe, using the Database Gateway from Micro Decisionware.

Visual Basic costs £139 but registered users of QuickBASIC and the BASIC PDS can get a copy for a mere £79. The VB Control Development Kit is priced at £39 and the SQL Server SDK costs £335. Microsoft is on 0734 500741.

386 DOS Extender Upgrade

Phar Lap has released a new DPMI compliant version 4.0 of its 386 DOS Extender. This will allow DOS-extended applications to run under Windows 3.0 enhanced mode. DPMI (DOS Protected Mode Interface - see .EXE April '91) is a new industry standard which allows protected mode DOS applications to run under Windows and future multi-tasking environments certified as DPMI compliant (eg OS/2 V2.0). It should now be possible for extended DOS programs to communicate with Windows programs via the clipboard. Phar Lap's 386 DOS-Extender V4.0 is the first extender to support all five industry standards (INT 15, VCPI, XMS, DPMI and VDS) and is also compatible with the new DOS 5.0.

Phar Lap's 386 DOS-Extender SDK V4.0 costs £325 and is supplied as a free upgrade for V3.0 users. To upgrade from V2.2d costs £145 and £25 for 386 VMM. Prices quoted are from System Science on 071 8331022.

Entertaining Mr Sloane

dBASE IV version 1.1, Ashton-Tate's ubiquitous DBMS, is now available on Intel 80386/486-based PCs running UNIX. The product should look and feel very much like the DOS version, but as the company's UK managing director, Paul Sloane, put it: '[it] takes advantage of the multi-user, multi-tasking functionality and value-added performance features of SCO operating systems' (sic). In the last six months dBASE IV versions have also been released for SunOS, VAX/VMS and Macintosh.

dBASE IV for 386 UNIX will run on five desktop systems: SCO UNIX V/386 and SCO XENIX 386, AT&T UNIX V/386, Interactive UNIX V/386 and ESIX System V. Prices start at £795. Ashton-Tate is on 0628 33123.

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Analog Devices/Edsun Laboratories claims that its continuous edge graphics digital to analogue converter (CEG/DAC) will dramatically improve the appearance of lines and circles on a standard analogue colour VGA monitor, by using a method of anti-aliasing. True 24-bit colour images can be displayed on an 8-bit system using dynamic palette loading. The CEG/DAC costs £49.95. For further information contact Computer and Peripheral Technology Limited on 0329 825152.

Books for us

A new bookshop has opened in London and its just for computer buffs. Books are arranged by subjects, and if perchance you're not able to tear yourself away from your PC, a mail ordering facility is also available. The PC BookShop is at 21 Sicilian Avenue, Southampton Row, London WC1A 2QH, tel 071 8310022.

PC-MOS Source Code Licence

A Source Code Licence for TSL's PC-MOS multi-user operating system has been released. Costing \$17,500, it will allow DOS distributors, VAR or system integrators to adapt PC-MOS for their own applications. Contact The Software Link on 0101 404 4485465 for more information.

Fastest 386SX from AMD

AMD has introduced a new family of SX microprocessors. The Am386SXL is a 25MHz processor that is a plug-in replacement for the 80386SX, offering less than one milliamp power consumption in stand-by mode. The Am386SXL costs \$89 in quantities of a 1000. Contact Advanced Micro Devices on 0483 740440 for more information.

Conference on Software Engineering

The 3rd International Conference on Software Engineering for Real Time Systems, will be held from the 16th to the 18th of September at the Royal Agricultural College. For a copy of the conference programme and further information call the IEE Conference Services on 071 2401871 ext 325.

Access to X.400 for AppleTalk

Intergralis has released Worldtalk 400, a package that allows users of Microsoft Mail on AppleTalk networks to send and receive mail from users on X.400 systems. Users can choose their preferred E-mail package and, at the same time, get access to the X.400 services. WorldTalk Microsoft Mail Edition costs £7900. For more information contact Microsoft Corporation on 0734 391123.

Letters

We welcome short letters on any subject that is relevant to software development. Please write to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. Unless your letter is marked 'Not for Publication', it will be considered for inclusion on this page.

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Andrew Gravell

*Dept of Electronics and Computer Science
University of Southampton*

Sounds like a great idea to me - Editor.

Hmm... - Advertising Manager.

GOTO spoof?

Sir,

I read Mark Hurst's article in the June issue of .EXE with considerable interest. I subscribe entirely to his views but was rather perplexed at the code fragment given, which seems to overturn the very opinions he had just expressed. Unless it is a subtle and clever spoof, and I just missed the joke, I have to admit that it is an ingeniously contrived way of 'justifying' a GOTO, not that I've ever particularly felt that it was something that needed an excuse anyway.

Perhaps we should now inform Messrs Kernighan and Ritchie that 20 years of progress has led us to a position where we can recast the 'Hello, world' program in a more

readable and readily maintainable form - see Figure 1.

*Graham Stokes
Warminster
Wiltshire*

5.1 trouble

Sir,

Is the nightmare flaw in the `printf` routine of Microsoft C, version 5.1, common knowledge? Try the program in Figure 2 and you will see what I mean. Repeating the process with `p = 0.00097856` suggests that the algorithm used is totally incorrect.

*MJ Healy
Harpenden
Herts*

For the benefit of any readers as ignorant/forgetful as myself, the use of a '.' in a `printf()` format specifier dictates 'the number of characters to be printed, the number of decimal places, or the number of significant digits' depending on the type character being used (Microsoft C 5.1 manual). Unfortunately, I have been unable to duplicate Mr Healy's experiment, the office copy of the C 5.1 software having gone AWOL. Borland C++ prints out 0.00030.000280.000279, which seems reasonable.

High Cast

Sir,

Can any one of the 350,000 Borland C++ users out there tell me how I can construct and index (or iterate) through an Array which contains objects that are multiply derived when the compiler will not allow me to typecast from `Object&` to `multiplyDerivedClass&`?

Yours in frustration++

*Dave Midgley
Macclesfield
Cheshire*

PS Get well soon, Verity.

```
#define BLOCK_START      {
#define BLOCK_END        }
#define PROGRAM_KERNEL   main()
#define DO_PRINT          printf
#define TEXT_MESSAGE      "Hello, world\n"
#define ESSENTIAL_PIECE_OF_SYNTAX ;

#include <stdio.h>

PROGRAM_KERNEL
BLOCK_START
DO_PRINT(TEXT_MESSAGE)ESSENTIAL_PIECE_OF_SYNTAX
BLOCK_END
```

Figure 1 - #define world

```
#include <stdio.h>
void main(void)
{
    float p = 0.00027856;

    printf("%.1g   %.2g   %.3g\n", p, p, p);
}
```

Figure 2 - printf problems

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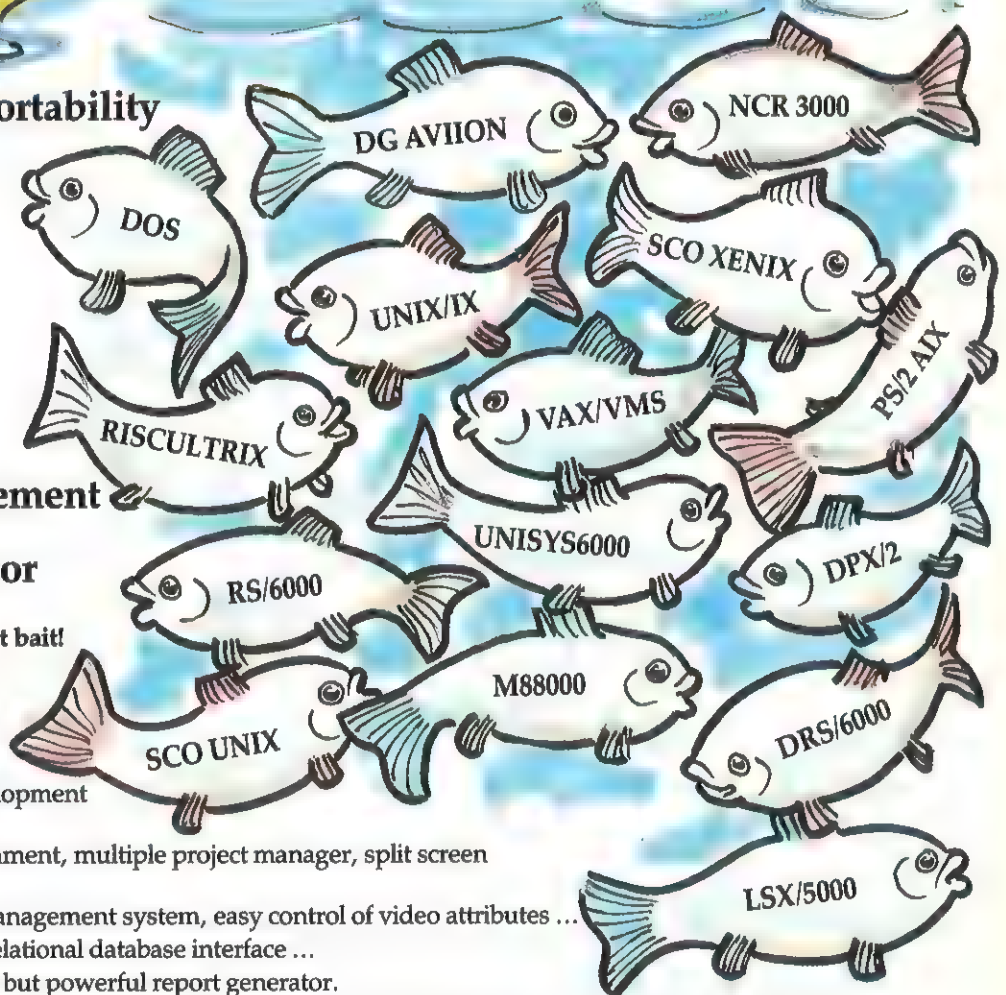
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EXE 8/91

Simula snub

Sir,

The May issue of .EXE had an article entitled 'Why programming is hard'. A good idea to write about. And there were many good things in that article. But: The author thinks that OOP is the same as Smalltalk. That is not true. He also thinks that Smalltalk is the grand-daddy of OOP (page 59 3rd column).

I can understand that somebody not reading .EXE could make that mistake. But .EXE is the only magazine that I know which has published an article about the 'real grand-daddy' - and not so long ago at that. The November '90 issue of .EXE told the story of the 'Language that would not die' - all about Simula, the first OOP language. It was not from the US and it is not a new thing. It came from Norway, 24 years ago!

Maybe a good article could be: Why do we refuse to learn from experiences of our own and others? One of the persons behind Simula, Kresten Nygaard, has since worked on a Nordic project designing and implementing a new OOP language called Beta. I commend this to

.EXE readers as a very interesting thing.

John Plate
Copenhagen
Denmark

... and QEMM snub

Sir,

It's difficult to imagine a more superficial and insubstantial review of MS-DOS 5.0 than Mark Hamilton's in the July '91 issue, but then it was only intended as an introductory article. However, it does contain a glaring factual error.

It was Quarterdeck Office Systems who were the first to exploit the High Memory Area, and not Microsoft. No way are Microsoft leaders in any form of technology, and they never have been. MS-DOS 5 doesn't compare well with DR DOS 5 (you can't load the DOS kernel into a UMB as you can with DR-DOS) and has at least 12 significant disadvantages compared to third-party memory managers such as QEMM-386.

Andrew Ward
Award Software Ltd
Harpenden

Mark Hamilton wrote his article under close supervision from this office. I felt that information on any new DIR switches in DOS 5 and graphical shells would be widely obtainable from other, less technical journals and, in the small amount of space that I had available in that issue, decided to concentrate on the API and other low-level issues.

Apologies to Quarterdeck for mis-attributing the discovery of the HMA.

I think that Mr Ward's attack on Microsoft is rather over the top (after all, Microsoft's fortunes were founded on a very innovative implementation of BASIC; there are many who believe that the company is about to score again with another). I also think that he is a bit of a tease for not listing at least some of his '12 significant disadvantages' - Ed.

Letters submitted to this page may be edited. The writer of the best letter of the month, as judged by the Editor, will be rewarded by a T-shirt or similar-valued .EXE trinket. The best letter is the one printed first.

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JPI introduces SmartMethod™ linking to new TopSpeed OOP languages.

Smart linking, the feature which eliminates unwanted procedures and data, first introduced in JPI's TopSpeed Modula-2, has been extended to the recently released TopSpeed C++ and TopSpeed Pascal. SmartMethod linking eliminates unref-erenced classes, methods, and even virtual methods within the same hierarchy, from the final executable program. A breakthrough for object oriented programming, SmartMethod linking saves programmers from having to sacrifice the elegance and functionality and virtual methods because of program size constraints.

As well as SmartMethod linking, all TopSpeed languages share the same development environment, common optimizing code generator available for DOS, OS/2 application development and memory.

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CIRCLE NO. 049

FORTRAN 90, the new FORTRAN Standard

*The new FORTRAN standard has at last been finalised, and the first compiler announced.
John Reid explains the advantages of the new language definition.*

It has been a long haul, but the new FORTRAN standard was finalised, down to the last editorial detail, on April 11th, and the first compiler has been announced. This seems a good moment to explain the advantages of the new standard and briefly review its history. Of course, I cannot give a complete description in an article of this length. If you want to know more, there are two books available and soon you will be able to purchase the official standard (details at the end of this article).

History

FORTRAN was the first computer language ever to be standardised. The original standard of 1966 was replaced by a new standard in 1978 and the languages have become informally known as FORTRAN 66 and FORTRAN 77 (it is not FORTRAN 78 because the technical content was completed in 1977). FORTRAN 77 was a modest revision of FORTRAN 66 and the ANSI committee X3J3 felt under tremendous pressure to

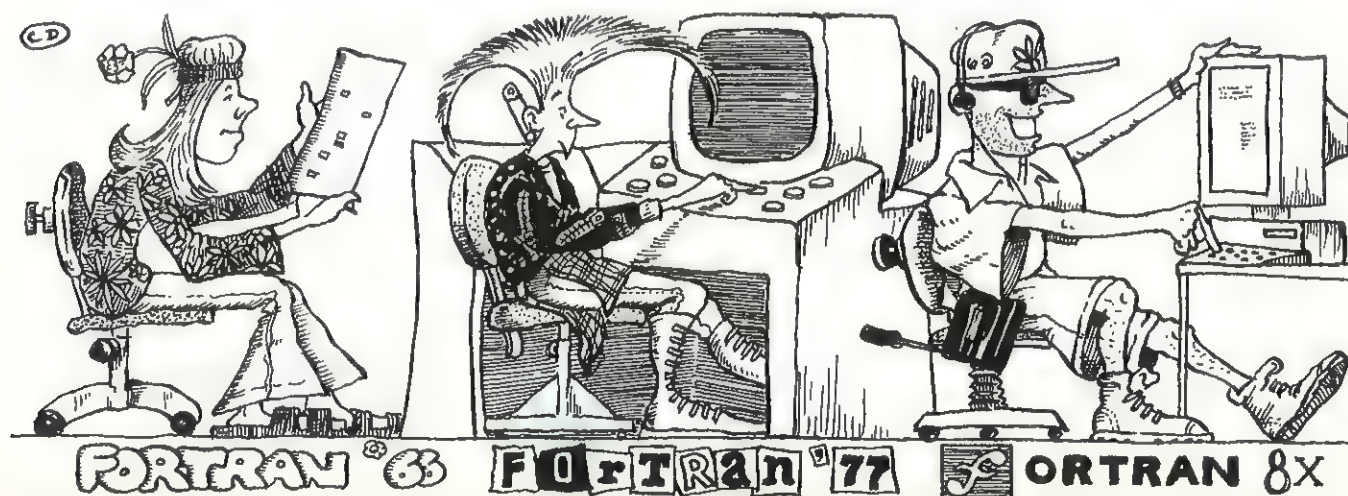
add further features, such as dynamic storage and array syntax. It therefore went immediately into a 'tutorial' mode, learning about experiences in other languages, and aimed to produce a new standard in 1982. In fact, by 1982 most of the new features had been agreed, each as a separate extension, and the task of integrating everything into a new document began. This was when I attended my first meeting and I became a member of X3J3 at the start of 1983. The draft was then known as 'FORTRAN 8x' and I expected that the unknown x would have the value 8 at most.

The basic reason for the delay was the difference of opinion between those who wished to see a large range of new features and those with more modest goals. A ballot of X3J3 held in April 1986 was 16 to 19 against the draft of that date and led to some slimming down of the language. A second ballot held in January 1987 showed that better agreement had been reached (29-7) and a draft was issued for

```
SUBROUTINE X(N,A,B)
INTEGER N, A(N), B(N)
INTEGER WORK(N,N)
INTEGER, ALLOCATABLE ::
HEAP(:, :)
```

Figure 1 - Declaring dynamic arrays

public comment later that year. Over 400 letters were received, representing varying shades of opinion, some welcoming the power and safety of the new features but many saying that the language was too complex and lacked certain popular extensions. The rules of X3J3 say that, at this stage, no change may be made without a 2/3 majority vote. This led to deadlock for two meetings. Finally, in September 1988, the ISO committee WG5, despairing of ever seeing a standard emerge from X3J3, defined exactly which changes it required and set a timetable for the preparation of a second draft.




```

TYPE POINT
  REAL X, Y
END TYPE POINT
TYPE (POINT) A, B(10,20)

```

Figure 2 - A derived type for points

Since 1988, progress has been steady, although there have always been about 10 'no' votes for successive versions of the whole standard - not enough to prevent acceptance by a 2/3 majority. A second draft was issued for public comment in 1989 and the 150 responses were largely favourable. A third draft in 1990 provoked only 29 letters. The new standard was finalised on April 11th. The technical content was completed last year, which is why the name 'FORTRAN 90' has been chosen (just as with FORTRAN 77, which was completed in 1978). The camera-ready copy was sent to ISO in Geneva at the end of April and the publication date is expected to be in the first week of August.

Language evolution

FORTRAN has been around for a long time and there is a huge volume of working code. To protect this investment, FORTRAN 90 is a proper superset of FORTRAN 77 - a program that conforms to FORTRAN 77 will conform to FORTRAN 90 too. This aspect has never been controversial within the committee.

Looking to the future, the committee has given everyone a warning of possible deletions in the next revision by labelling a small number of features that have replacements in FORTRAN 77 as 'obsolescent'. Many shops already advise against the use of these features and again this has not been controversial within the committee. The features involved are:-

- Arithmetic IF

```

MODULE INTERVAL_ARITHMETIC
  TYPE INTERVAL
    REAL LOWER, UPPER
  END TYPE INTERVAL
  INTERFACE OPERATOR(+)
    MODULE PROCEDURE ADD_INTERVALS
  END INTERFACE
CONTAINS
  FUNCTION ADD_INTERVALS(A,B)
    TYPE (INTERVAL) ADD_INTERVALS, A, B
    ADD_INTERVALS%LOWER = A%LOWER + B%LOWER
    ADD_INTERVALS%UPPER = A%UPPER + B%UPPER
  END FUNCTION ADD_INTERVALS
END MODULE INTERVAL_ARITHMETIC

```

Figure 3 - A module for interval arithmetic

- Non-integer DO index
- DO termination other than on a CONTINUE or END DO statement
- Branching to END IF from outside its block
- Shared DO termination
- Alternate return
- PAUSE
- ASSIGN and assigned GO TO
- Assigned FORMAT specifiers

Array features

The fact that all FORTRAN 77 arrays are static is a very big deficiency. FORTRAN 90 contains 'automatic' arrays, created on entry to a subprogram and destroyed on return, and 'allocatable' arrays whose number of subscripts (rank) is fixed but whose actual size and lifetime are fully under the programmer's control through explicit ALLOCATE and DEALLOCATE statements. The declarations in Figure 1 include an automatic array WORK and an allocatable array HEAP. Note that a stack is an adequate storage mechanism for the implementation of automatic arrays, but a heap will probably be needed for allocatable arrays.

These two changes represent an enormous advance from FORTRAN 77 with its static storage. There will no longer be any need for work-space to be set up by the user of a library procedure or for the argument list to be cluttered with work-space arguments. It will now be straightforward to structure global storage according to the size of the problem in hand and there will no longer be any need for complicated and unsafe storage management schemes within the code itself.

Dummy arrays may be 'assumed-shape' (take their shapes from the corresponding actual arguments). No longer will we need to specify the leading dimensions of arrays as separate arguments when calling library codes. Arrays may be of size zero, which will mean that we no longer have to write special-case code in case it happens. Arrays may be used in whole-array expressions such as

$$B + C * \sin(D)$$

The operations are performed element-by-element, that is the sine function is applied to each element of D, multiplied by the corresponding element of C, and added to the corresponding element of B. The arrays must have exactly the same shape, but scalars may be intermixed freely. Array expressions may be used as actual arguments. They may be used in whole array assignments such as

$$A = B + C * \sin(D)$$

provided the left-hand side array has exactly the same shape as the expression. Note that there is scope for a computer to exploit fully multidimensional arrays in a statement such this, whereas if it is rewritten in the form of nested DO loops, existing vectorisation techniques often vectorise only the innermost loop.

Rectangular sub-arrays, called 'sections', may be used as arrays. Examples are A(:,7) which is the 7th column of A and A(2:10:2,7) which consists of components 2, 4, 6, 8, 10 of the 7th column of A.

Functions may be array-valued. Almost all the FORTRAN 77 intrinsics (and a few new ones) may be called 'elementally' in the way SIN was called in the above example. There are many new inquiry intrinsics that return the array properties of their arguments and many new array-valued intrinsics, for example MATMUL for matrix multiplication, MAXVAL for the largest element, and SUM for summation.

Arrays of rank one may be constructed as lists of scalars and other arrays of rank one, just as in input-output statements in FORTRAN 77. An example of an array constant of size 10 is

```

(/ 21.0, 2.7, (21.0,2.0, &
                                I=1,4) /)

```

There is a RESHAPE intrinsic function to allow arrays of other shapes to be constructed.

WHERE statements allow array assignment statements to be masked. For example

```

WHERE (A.GT.0) B=LOG(A)

```



```
INTEGER, PARAMETER :: SKIND = SELECTED_REAL_KIND(10,99)
REAL(SKIND) A
```

Figure 4 - Selecting precision

```
INTEGER, PARAMETER :: LONG = SELECTED_REAL_KIND(10,99)
INTEGER, PARAMETER :: SHORT = SELECTED_INT_KIND(5)
REAL (LONG) PI
INTEGER (SHORT) ISHORT
PI = 3.141592654_LONG
ISHORT = 12_SHORT
```

Figure 5 - Using kind parameters

causes the evaluation and assignment of logarithms only for elements that are positive. There is also a block form with an optional ELSEWHERE block.

Derived data types

FORTRAN 90 permits data to be grouped into a structure. For example, Figure 2 shows the declaration of a 'type' for the x and y coördinates of a point together with the declaration of a scalar and an array of this type. The symbol % is used to select a component; for example, A%X is the X component of A (unfortunately the C/Pascal '.' is unavailable because of its use for operators such as .GE.).

Functions may be used to define operations on these compound data types and subroutines may be used to define assignments between them. The operators may be intrinsic (for example +, *, .EQ.), in which case the existing priorities are used for the new operators, or non-intrinsic (for example, .MERGE.), in which case the priority is maximum for unary operators and minimum for binary operators.

Derived data types provide the language with a powerful form of extensibility. It means that ordinary in-line operator notation will be available for matrices, extended precision arithmetic, interval arithmetic etc.

Modules

Modules are collections of data, type definitions, and procedure definitions. For example, a module for interval arithmetic is shown in Figure 3. It contains the definition of a type whose components are the lower and upper bounds of the intervals, a procedure for adding two intervals and an interface block that tells the compiler to associate this function with the + operator.

Access to this module requires a USE statement whose simplest form is

```
USE INTERVAL_ARITHMETIC
```

To allow for possible name clashes, there is a renaming facility. Also, access may be restricted to a list of entities.

Modules provide a safe replacement for COMMON. Note that the definitions are given only once. It is more general than COMMON in that type and procedure definitions are included. It is likely that libraries will become libraries of modules instead of libraries of procedures.

Procedures

A procedure may be called recursively provided its leading statement includes the qualifier RECURSIVE. It may be internal (at one level only) to an external subprogram or to a subprogram in a module. Keyword calls, as in the I/O statements of FORTRAN 77, are available. The dummy argument names serve as keywords. Arguments may be omitted provided they are declared as OPTIONAL. The intrinsic function PRESENT may be used to inquire whether an optional argument is present. Dummy arguments may be declared to be IN, OUT, or INOUT.

Interface blocks that contain statements just like the leading statements of a procedure may be used to specify the interface to an external or dummy procedure. For example, this permits keyword calls to be made to a procedure written in assembly language. An interface block may also be used to give a generic name to a set of procedures, provided they may be distinguished by the types or ranks of their arguments. This is exactly as for the specific and generic intrinsic functions in FORTRAN 77.

Kind parameters

All the intrinsic types have been generalised to have a 'kind' parameter. This will permit processors to support short integers, very large character sets such as Japan's Kanji, more than two precisions for real and

complex, and packed logicals. In the case of REAL and COMPLEX, there must be at least two kinds, corresponding to single and double precision. There is an intrinsic function that returns the kind value for a desired precision and exponent range. For example, the code of Figure 4 finds the kind value of the least precise machine representation that gives the equivalent of at least 10 significant decimals and a range of at least 1E-99 to 1E+99, and uses this to declare a real variable.

There are many inquiry and manipulation intrinsic functions that return information on the representation or manipulate parts of data (for example, extract the fractional part).

Constants may be specified with the help of an underscore and an integer constant that gives the kind value. Some examples are shown in Figure 5.

Pointers

Data objects may be declared with the attribute POINTER. Such an object does not have any storage until it is explicitly allocated for it by an ALLOCATE statement or it is 'pointer associated' with an existing target object:

```
POINTER => TARGET
```

In the case of an array, only the rank is declared initially:

```
REAL, POINTER :: A(:, :)
```

and a shape is acquired when it is associated with a target.

As a simple example of the use of pointers, suppose we have code that performs the matrix-vector product $y = Ax$ and wish to calculate the product BCz . We might pointer associate y, A and x with r, C and z respectively, use our code to find $r = Cz$, then pointer associate y, A and x with s, B and r and use our code to place the result we want in s.

Components of derived types are permitted to have the pointer attribute. This permits a major application of pointers: the construction of linked lists. As a simple example, we might decide to hold a sparse vector as a chain of variables of

```
TYPE ENTRY
  REAL VALUE
  INTEGER INDEX
  TYPE(ENTRY), POINTER :: NEXT
END TYPE ENTRY
```

Figure 6 - A type for holding a sparse vector as a chain

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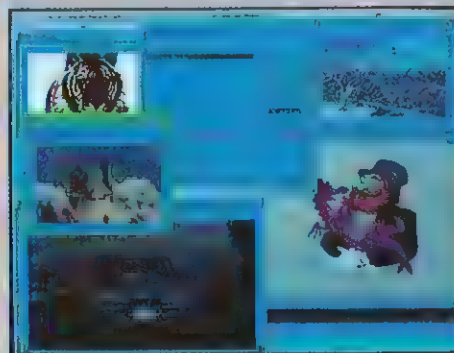
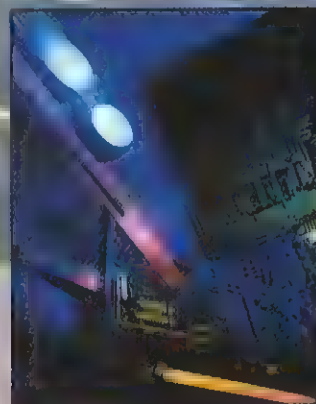
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the type shown in Figure 6, which allows us to access the entries one by one and create additional entries when necessary by an appropriate `ALLOCATE` statement. When an ordinary assignment is executed for a value of such a derived type, pointer assignment is executed for the pointer components.

To avoid performance degradation for non-pointer objects, the attribute `TARGET` must be declared for a non-pointer object that is to be used as a target.

There is an intrinsic function that allows enquiries to be made about whether a pointer is pointer associated and whether it is pointer associated with a given target. There is a `nullify` statement to disassociate a pointer.

Source form

The FORTRAN 77 limit of 6 characters in a name is raised to 31, and in-line comments following the character `'!` are permitted. These two simple changes will make an enormous difference to the readability of code.

There is also a free source form that attaches no particular significance to columns 1 to 6 or 72 onwards, does not allow blanks within tokens (with a few exceptions such as `END IF`), and uses a terminating `'&'` to indicate continuation to the next line. Lines may have length up to 132 characters and statements up to 40 lines.

Miscellaneous bits

The only major new input-output features are `NAMLIST` and non-advancing I/O. Non-advancing I/O obviates the FORTRAN 77 insistence that records must be read as a whole and that their length be known beforehand. It is specified with `ADVANCE='NO'` on the read or write statement and inhibits the automatic advance to the next record on completion of the statement. On a read, if the record contains insufficient values to satisfy the input list, an end-of-record condition results and a `SIZE=` specifier may be used to return the number of characters read.

There are two new control structures. The `CASE` construct is exemplified in Figure 7.

```

INTEGER N
SELECT CASE (N)
  CASE (:0)      ! N negative or 0
  :
  CASE (1)       ! N = 1
  :
  CASE (5:7)     ! N = 5, 6 or 7
  :
  CASE DEFAULT ! Any other value
  :
END SELECT

```

Figure 7 - The case construct

```

INTEGER I
OUTER: DO          ! Unlimited DO, named OUTER
  :
  DO I=1,N         ! I=1,2,...,N
  :
  IF (...)EXIT OUTER ! Possibly exit outer loop
  IF (...) CYCLE     ! Skip to end of loop
  :
END DO
END DO OUTER

```

Figure 8 - The DO construct

There is also a form of the DO loop that does not use labels, exemplified in Figure 8.

The MIL-STD bit intrinsic functions have been added (and made elemental).

Binary, octal, and hexadecimal values are permitted in `DATA` statements and there are edit descriptors for them.

Compilers are required to be able to detect the use of constructs that do not conform to the syntax of the language or are obsolescent.

Implementations

The last few years have seen a steady increase in the number of people attending X3J3 meetings, mainly from the vendors. Many of them have been actively working on implementations, but are unwilling to commit themselves to dates for release of compilers. The Numerical Algorithms Group Ltd (NAG) in Oxford, has just launched a full ISO-conforming FORTRAN 90 compiler. It has already been used to check all the examples in my book with Mike Metcalf, and is being used by NAG to begin development of its FORTRAN 90 library. NAG's compiler is a development tool and will be available on a wide range of hardware types, since it depends only on the presence of a C system. Production compilers are likely to appear from 1992 onwards.

Conclusions

I have aimed to give you a flavour of how the new standard will benefit users of FORTRAN. For example, the additions will make libraries much more friendly to

use. Optional arguments, dynamic storage, and assumed-shape arrays will mean that the user need only specify what is truly special to the particular problem; and arguments may be grouped logically together into a derived type. In one case, I found that 73 arguments could be reduced to 6. If you want to have the power and safety of the new features, without the need to rewrite your code in another language, put pressure on a vendor whenever you get a chance.

EXE

John Reid is a Senior Research Scientist at the Atlas Centre of the Rutherford Appleton Laboratory. His main research interest is in the treatment of sparse matrices and he has been writing general-purpose software in FORTRAN since the 1960s. He has been a member of the X3J3 (FORTRAN) committee since 1983 and was its secretary from 1987 to 1990.

Copies of the standard (ISO/IEC 1539:1991) can be ordered from BSI Sales Dept, BSI, Linford Wood, Milton Keynes, MK14 6LE or directly from ISO, Publications Dept, Case Postale 56, 1211 Geneva 20, Switzerland. The ISO publication date will probably be August and the BSI date is likely to be a few months later.

An informal description of the whole language is contained in FORTRAN 90 Explained by Mike Metcalf and John Reid, Oxford University Press, ISBN 0-19-853772-7.

A book that covers the principal new features and contains more examples is Programmer's Guide to FORTRAN 90 by W S Brainerd, C H Goldberg and J C Adams, McGraw-Hill, ISBN 0-07-000248-7.

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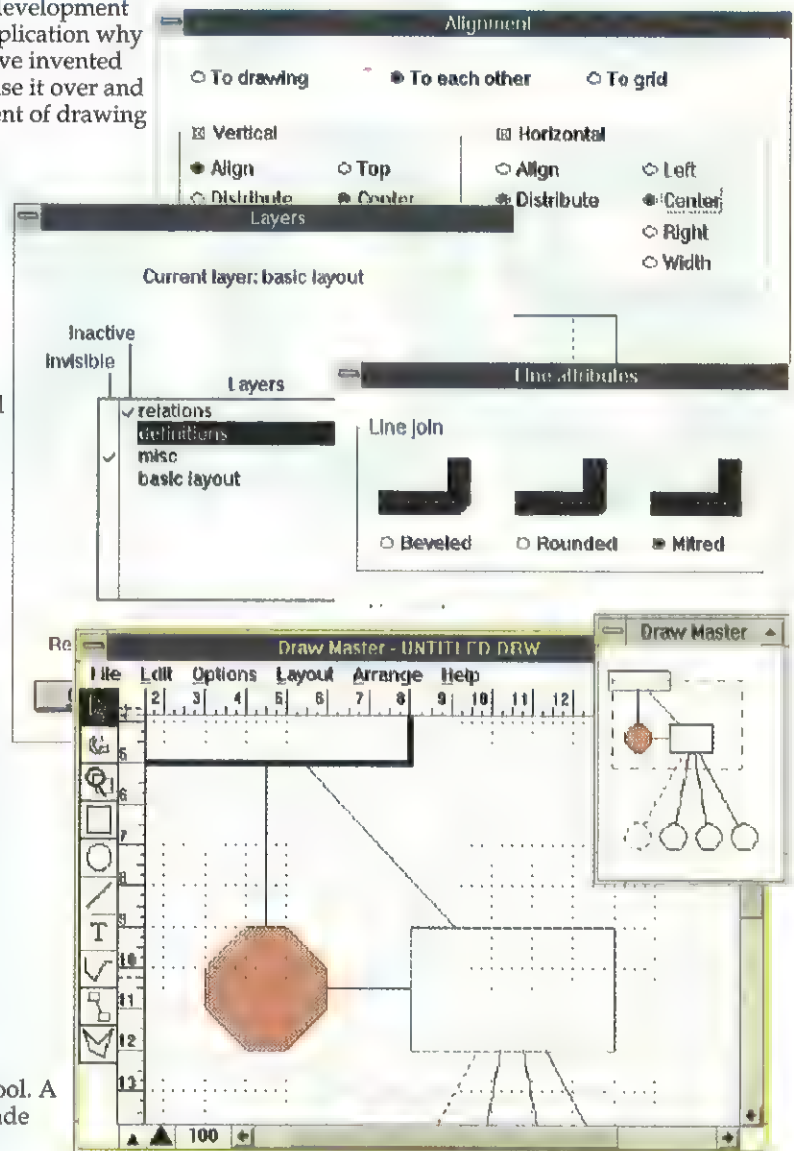
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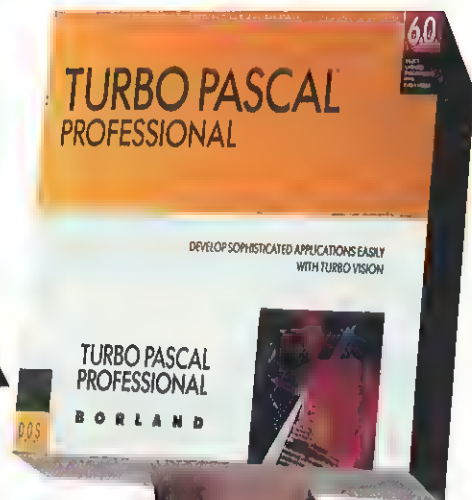
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EXE 8/91

Three COBOL Jewels?

Vincent Kilcoyn feels that COBOL has been neglected.

Here he looks at some modern COBOL extensions and three compilers which provide them.

Over the last decade many advances have been made in programming languages. Pascal and C++ are rarely out of the headlines. COBOL seems to have been left behind. In an attempt to rectify the language's

somewhat stale image, manufacturers have come up with some highly viable versions of COBOL which incorporate, to some extent, what a modern programming language should provide.

Three such versions are Microsoft Cobol from that eponymous party, RM-Cobol from Ryan McFarland and Acu-Cobol from the comparatively unknown Acu-Cobol Inc. All three can be rated as excellent compilers catering for the MS-DOS environment, and this is the platform used as the basis of comparison in this article. (The evaluations were carried out on a 386SX PC running at 20MHz with a 17ms Hard Disk.) It is worth noting, however, that all the compilers support other machines/OSs. Microsoft's compiler comes complete with full OS/2 support, and both Acu-Cobol and particularly Ryan McFarland are portable between a wide range of larger platforms, offering the possibility, for example, of doing development work on PCs without consuming the departmental mini's precious CPU time.

In common

All three compilers fully support the ANSI-85 standard (more on this later), and also provide a number of language extensions. These extensions are mainly in the area of file handling and windowing.

Happily, the file handling extension, which provides the programmer with the facility to read backwards through an indexed file, has been implemented in the same way by all three compilers. The syntax for this extension is `READ <filename> PREVIOUS RECORD`.

Another facility provided is the ability to use the `START` verb with a `LESS THAN` or `LESS THAN OR EQUAL TO` qualifier. This statement provides the programmer with an ideal tool to access, for example, the last transaction on an account. The addition of these two extensions fills in




```
IF linecount >= 55 THEN
  MOVE 0 TO linecount
  ADD 1 TO ws-page-no
  PERFORM Newpage
END-IF
```

Figure 1 - IF...END-IF statement

the last gap in COBOL's already comprehensive file management facilities - facilities which, in the opinion of the writer, are still unmatched by any other programming language in use today.

But the windowing extensions must be the most dramatic enhancements. The modern COBOL programmer is now able to impress both his existing users and potential customers with flashy forms and clever menus. The days of struggling with cumbersome DISPLAY statements to try and put something half-decent on the screen are gone.

Unfortunately, with these extensions, the manufacturers have reverted to type: all three compilers have taken a different tack in implementing windowing. RM and ACU have extended the DISPLAY verb to include a window option, but the syntax is not the same. Microsoft offers several different methods, using add-on tools such as a dialog manager.

ANSI-85

Let us look for a moment at the features introduced by the ANSI-85 standard. The main impact of ANSI-85 is to improve program structure. Many statements can now be delimited with a suitable 'END' terminator, for example IF...END-IF. Because of these, the programmer now has the facility to produce much more readable code (see Figure 1).

```
IF ws-month = 2 THEN
  IF ws-days = 28 THEN
    MOVE "Y" TO ws-days-ok
  ELSE
    EVALUATE ws-days
      WHEN 29
        IF ws-leapyear = "Y" THEN
          MOVE "Y" TO ws-days-ok
        ELSE
          MOVE "N" TO ws-days-ok
        END-IF
      WHEN OTHER
        MOVE "N" TO ws-days-ok
    END-EVALUATE
  END-IF
END-IF
```

Figure 2 - Nested IFs

This also allows the programmer to cater for nested IFs (Figure 2) - a daunting task indeed when using the old syntax. The language also now boasts an EVALUATE statement, equivalent to Pascal's case construct, which can be used to replace some repeated IF structures. There is also an in-line PERFORM - see Figure 3.

Programmer's WorkBench took approximately 20 seconds to check a small program, and the same again to reload itself

The CALL statement makes a large number of callable subprograms a viable proposition. Each subprogram has a very clean interface defined in a LINKAGE SECTION, somewhat reminiscent of Modula-2's module headers. An improvement in performance is provided by the introduction of sophisticated memory management algorithms within the environment.

Taking all the above into consideration, one must come to the conclusion that development is now far superior to that provided by the older implementations of the COBOL language.

Microsoft COBOL

The Microsoft compiler arrived in a huge box, raising my hackles about the number of manuals that would have to be assimilated before installation. The size of the manuals was also, unfortunately, reflected in the amount of hard disk space required to accommodate the compiler and its flock of add-ons, which together consumed approximately 6 MB of my hard disk. This reflects the comprehensive nature of the package, which contains a debugger, Programmer's WorkBench and linker, to name but a few.

After spending some time digesting the manuals, one could be quite confident in approaching a new program, especially if armed with some experience in the IBM COBOL environment. This COBOL is ideally suited to IBM mainframe dialects and even provides an old favourite of those who have had MVS experience: Dialog Manager.

Both the syntax of the language and general approach are very much in keeping with IBM COBOL - unsurprising, since the software is based on a rebadged Micro Focus compiler - this latter being an IBM favourite. The compiler generates .EXE files which devour disturbing quantities of memory (especially when working within the confines of an MS-DOS based PC). However, the debugging facilities provided by the Animator tool must be admired - they are second to none.

One of the tools which was provided with the compiler was the Programmer's WorkBench. While this provided such facilities as code checking and integration of an editor with the compiler, it must, in my opinion, be regarded with some indifference due to its slow response times. It took approximately 20 seconds to check a small program, and the same again to reload itself.

Not really the type of thing one expects of a PC-based package. The generated code itself did prove to run quite quickly, mainly due to the compiler generating native object code (the other systems use a semi-interpretive p-code system).

RM-Cobol

This product proved to be substantially different from Microsoft's: there were far fewer manuals, and the software occupied much less disk space. The installation proved to be quite simple and the learning curve shallow. When I had the system up, I immediately noticed a

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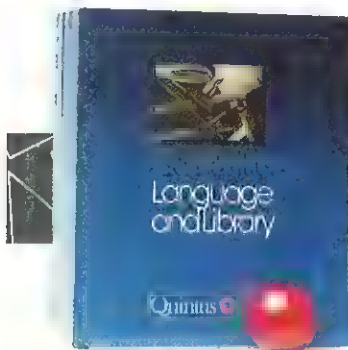
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marked difference in the amount of memory required by compiled programs. The compiler does not go all the way to executable code, which allows RM to reduce memory usage considerably.

Some of the features incorporated in the package reflect Ryan McFarland's many years in the Open Systems market; in particular the high degree of compression achieved on their files and the performance of the programs, especially in compute-bound applications. Personally, my biggest stumbling block with the software was the marked absence of any debug facility.

RM offers a range of add-on tools to support its compiler, namely RM-Panels and RM-Co*. RM-Panels provides comprehensive forms-development facilities in a well-presented environment.

The only down side of it is that the use of RM-Panels reduces the portability of software between compilers (although RM itself does offer a wide range). The RM-Co* product is aimed at being a programmer's workbench type thingy; it provides library handling facilities and other 'goodies'. Once again, however, I found it rather cumbersome to use and did not feel that its merits outweighed its drawbacks.

AcuCobol

AcuCobol is a comparative newcomer to the COBOL development scene, although this did not reflect negatively on the quality of the product. The packaging is very much to the point: there is only one manual and one disk.

Needless to say, installation was a very simple procedure, requiring only a brief glimpse at the manual. Once I had become familiar with the syntax for running the compiler, code development proved to be simple - and very similar to RM-Cobol. In fact, the compiler offers good compatibility with RM - there is even a compiler switch for RM compatibility (and another one for DEC VAX COBOL).

On compilation, AcuCobol won over the other packages both in terms of compila-

tion times and the amount of storage required by the compiled code. The performance of the code was satisfactory (although generally the slowest of the

The high memory usage of MS-COBOL makes the design and coding of medium to large systems unwieldy

three), and the compiler definitely 'preferred' I/O bound applications (which is, after all, what most COBOL programs are about).

AcuCobol lacks such frills as form generators and workbenches, though I dare say that these will be along in the future. Despite this no-frills approach, the product does provide an excellent debugger, and a file handling utility called 'VUTIL' which provides the programmer with facilities such as download, check integrity, rebuild index etc. It also contains an unusual convert option, which allows the user to convert RM-Cobol files and VAX RMS files to VISION files as used by the AcuCobol environment.

Personal Favourite

Despite the difference in performance between RM-Cobol and AcuCobol when put head-to-head on compute-bound and I/O bound problems, my preferred development environment is AcuCobol. This preference is based on a number of properties:

- Very Fast Compiler,
- Excellent Debugger,

- Compatibility,
- File Handling Utility, and
- Processing Speed.

Conclusion

In light of the above discussion it is necessary to view each compiler on its own terms; the 'Horses For Courses' cliché springs to mind. The languages in their skeletal forms are by and large compatible with one another, but when you start using the various extensions, this compatibility obviously tends to weaken.

One must analyse the type of application which is to be built and, in the light of such factors as environment; processing base; I/O or compute-bound; programming background; possible future trends and cross machine portability, decide on the relative merits of each system.

When the destination platform is an IBM-type mainframe, and is to be developed and maintained by people within that environment, then the choice in my opinion would be Microsoft COBOL. This is because of the similarity between MS-COBOL and IBM COBOL, and the fact that high memory usage by the programs makes the design and coding of medium to large systems unwieldy given the restricted resources of MS-DOS.

If the application is destined for either a PC or an 'Open System' environment then the choice should be either RM-Cobol or AcuCobol. The choice between these two should, in my opinion, be dictated by the nature of the processing; if the system is compute-bound then opt for RM-Cobol, otherwise choose AcuCobol.

EXE

Vincent Kilcoyne works for Solomons Stockbrokers in Dublin, Eire.

The AcuCobol Developer's kit for MS-DOS costs £950, and is available from the Software Construction Company (0763 244114).

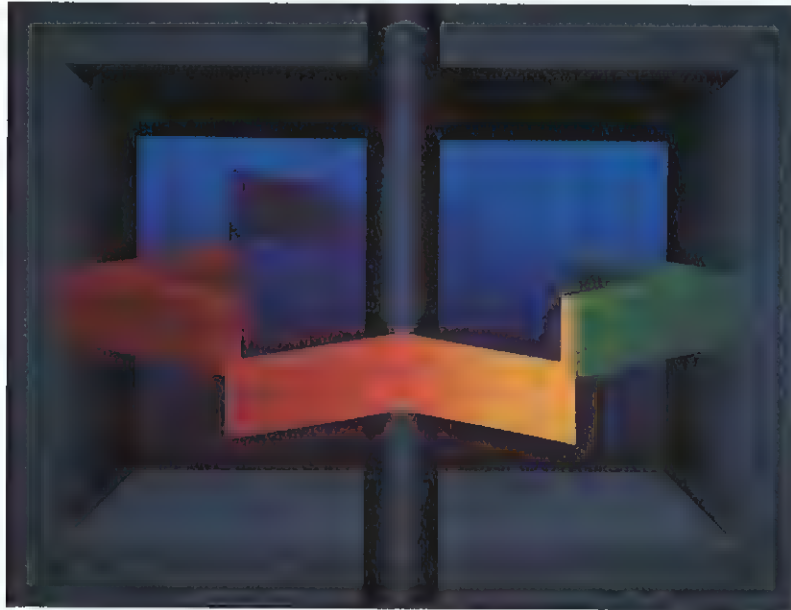
RM-Cobol for MS-DOS (bundled with RM-CO and RM-PANELS for a promotional period) costs £995 from System Science (071 833 1022).*

Microsoft COBOL for DOS and OS/2 costs £399, and is available from most dealers.

```
PERFORM VARYING sub FROM 1 BY 1
  UNTIL sub > 99
    MOVE 0 TO ws-value(sub)
    MOVE 0 TO ws-qty(sub)
END-PERFORM.
```

Figure 3 - An inline PERFORM statement

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Writing C++ Member Functions in Assembly Language

Zortech's C++ manual discourages punters from writing C++ member functions in assembly, but Laine Stump is not one to heed such warnings when there are bytes to be saved and clock cycles to be gained...

Most of you have had some experience with (or at least exposure to) linking assembly functions to your programs using the naming and parameter passing conventions of C, or 'C linkage'. While C++ programs can call these functions too, sometimes it is necessary to write assembly language functions which have C++ linkage. For example,

if you want to write a member function in assembly, it must have C++ linkage.

In this article, I'll show you how to write assembly functions with C++ linkage and, in particular, C++ member functions. I have used Zortech C++ V3.0 and MASM V5.1 for my experiments and examples. Turbo As-

sembler should work fine in place of MASM, as long as you use the `/jMASM51` directive. At the end of the article, I'll give a few pointers on interfacing with Turbo C++.

Much of the following information was obtained not from a manual, but from hours of studying disassembled code with a debugger. Although everything here is correct for the version of Zortech C++ I am using (V3.0), Zortech does not guarantee that it will work in any previous or future versions. It reserves the right to change the C++ linkage convention if necessary 'to accommodate future enhancements in the C++ language'.

Why Bother?

As it is possible to call functions with C linkage from a C++ program, you may question the utility (sanity?) of writing assembly functions with C++ linkage. The Zortech manual even suggests that you avoid writing assembly with C++ linkage, and use C linkage; if you need to have assembly language in a member function, write the member in C++ and have it call an assembly function with C linkage.

This will work, but it will defeat much of the point of writing in assembly language. The program will be larger because there will be two functions instead of one. It will be slower for the same reason - in order to get to the code you want to execute, you must push arguments onto the stack and call the member function, which will push the same arguments onto the stack in another location, and call the assembly function. Not a model of efficiency.

```
// OUTBYTES.ASM
// a function which can have either C or Pascal Linkage
// depending on what is given in the .MODEL
//
// to call from C, assemble with
//      masm /mx exam;
// #include "outbytes.h" in your program, and call as:
//      OutBytes(port, &vals, ct);

// output ct bytes of data at vals to port
.MODEL SMALL, C ; use PASCAL to call from Pascal
.CODE
.186             ; assume we will run on at least 80186
//
// void OutBytes(int port, char *vals, int ct)
//
OutBytes PROC  USES SI DS, \
    port : WORD, vals : PTR BYTE, ct : WORD
    MOV     DX, port
    IF (@datasize)
        LDS     SI, vals ; if far data model (C or L)
    ELSE
        MOV     SI, vals ; if near data model (S or M)
    ENDIF
    MOV     CX, ct
    CLD
    IF (@Cpu AND 2)
        REP     OUTSB ; only works on 186 & > CPUs
    ELSE
        OB 00:
        LODSB ;simulate REP OUTSB on 8086 and 8088
        OUT     DX, AL
        LOOP    OB 00
    ENDIF
    RET
OutBytes ENDP
END

// OUTBYTES.H - prototype for OUTBYTES.ASM

extern "C" void OutBytes(int port, char *vals, int ct);
```

Figure 1 - An assembly function with C Linkage

C++ Complications

Writing an assembly language replacement for a C++ member function is a bit more complicated than writing a function with C linkage. As with any language, you must know the parameter passing, naming, and value return conventions. But there are scads of details that will trip you up.

First, thanks to the magic of type-safe linkage and the process of 'name mangling' (encoding class and type information into the function names), the names of C++ functions aren't nearly as simple as C or Pascal functions. Second, every member function in C++ has a secret parameter called `this`; you must know where `this` is and how to access the data members to which it points. Third, calling another C++ function from assembly can prove trying on the nerves as, once again, you must construct a mangled function name. And we haven't even touched the subject of virtual member functions (yet)!

A Short Review

In C linkage, all names are case sensitive (case is preserved), with an underscore (`_`) stuck in front. Parameters are pushed onto the stack starting with the rightmost parameter (the first parameter is at the lowest address). Stack space taken by the parameters is released by the calling program, after return from the function, by adding a value to the SP register.

Pascal linkage makes all names uppercase, with no added characters. Parameters are pushed from left to right (the opposite order of C). Unlike C, the Pascal functions clean up the stack as part of the return (using a `RET nn` instruction).

Both languages send back return values (of up to four bytes) in the AL, AX, or DX:AX registers. Return values of larger size are not

standardised between compilers, and we will not discuss them here.

Most explanations of calling assembly from a high level language concentrate on what must be done with the BP register in order to access the parameters on the stack. MASM V5.1 removes all that drudge work. If you give a language qualifier in the `.MODEL` directive, MASM will not only convert the function name just as the Pascal or C compiler does, but will also allow you to list parameters and their types in the `PROC` statement, and use them in the function with the names you have given. And it will insert the proper 'prolog' and 'epilog' code in all functions to set up BP for use in parameter and local variable access. You'll never see BP anywhere in the functions, but be aware that it is in use, and must not be fooled with.

See Figure 1 for an example of an assembly function which can be assembled to be called directly from a Pascal or C program. If the language in `.MODEL` is C, an underscore is automatically added in front of all global labels (and all `PROC`s are made global). If the language is Pascal, nothing is added to the labels. MASM's `/mx` command line switch causes all global labels to be case sensitive (they are otherwise converted to uppercase). Thus, using the C qualifier along with `/mx` gives the name `_OutBytes` while Pascal without `/mx`, gives `OUTBYTES`.

Zortech C++ Linkage

While the Zortech compiler uses the 'standard' C linkage method for functions declared as C, for C++ functions it uses a hybrid of C and Pascal, with an extra twist.

C++ function names are given argument type information through a process called 'mangling'. Each name has an underscore

Type	code
char	c
short	s
int	i
long	l
float	f
double	d
long double	r
void	v
Prefixes	
near *	p
far *	P
reference	R
const	C
volatile	V
unsigned	U

Figure 2 - Mangling codes for simple data types

placed in front, and the case is preserved as in C. But tacked onto the end of the name (after two underscores) is an optional class name (for member functions), followed by type information for the function and its arguments. This is explained in detail in the Compiler Reference section titled 'Name Mangling in Zortech C++'. (an article on the same topic, but for Borland's Turbo C++, appeared in *.EXE Magazine*, February 1991) See the table in Figure 2 for a list of basic types and their encoding in a mangled function name. Classes and other complex types are encoded by giving a count of the letters in the class name followed by the name itself. In general, the mangled function name takes this form:

`<Name>_<n><Class><N|F><type-info>`

where *n* is the length of the class name. *N* means 'near function', *F* 'far function'. So, for `Disp::Puts(char*s)`, we would have (in Small model):

`_Puts_4DispNpc`

read as 'Puts is a member of class Disp, a near function with one argument, which is a near pointer to char'.

```
; INBYTES.ASM
; a non-member function with C++ Linkage
; input ct bytes of data from port to array at vals
;      masm /mx inbytes;

.MODEL SMALL, PASCAL ;near code, near data
.CODE
.186 ;enable assembly of 186 & up instr.
;;
;; void InBytes(int port, char *vals, int ct)
;;
_InBytes__Nipci PROC USES DI, \
    port : WORD, vals : PTR BYTE, ct : WORD
    MOV     DX, port
    IF (@datasize)
        LES     DI, vals ; if far data model (C or L)
    ELSE
        MOV     DI, vals ; if near data model (S or M)
        MOV     AX, DS    ; all data is relative to DS
        MOV     ES, AX
    
```

```
ENDIF
    MOV     CX, ct
    CLD
    IF (@Cpu AND 2)
        REP     INSB ; only works on 186 & > CPUs
    ELSE
        IB_00:
            IN     AL, DX ;simulate REP INSB
            STOSB
            LOOP   IB_00
    ENDIF
    RET
_InBytes__Nipci ENDP
END

// INBYTES.H - prototype for INBYTES.ASM

void InBytes(int port, char *vals, int ct);
```

Figure 3 - A non-member function with C++ Linkage

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As more arguments are added to a function, their type information is appended to the end of the name. Return types are not included in the mangling information.

There are many other sneaky rules about name mangling. For example, if the type information of an argument is longer than two characters, and if another argument in the same function has the same type, it is encoded as 'Tn', where n is the position of the first occurrence of that type in the argument list.

The best way to learn the mangled name of a function is to write the function in C++ and compile it with debugging turned on (-g). Then examine the .MAP file produced by the linker. Alternately, compile the function, then run OBJTOASM on the output. Either method will show you the exact name, as mangled. Use this name as a model for your assembly function.

C++ Parameters

Surprisingly, in the Zortech C++ linking convention, parameters are passed as in Pascal - they are pushed onto the stack from left to right, and are cleaned from the stack by the RET statement of the called function. The reason for this is speed and compactness. The C method is more flexible, as it allows calling the same function with different numbers and types of arguments (eg printf()), but it has more instructions (the RET and stack adjustment are separate).

If a C++ function has an ellipsis in its argument list, C parameter passing is used instead. As these are infrequently used, we will ignore them for now.

In order to satisfy both the parameter passing and naming conventions, I use .MODEL Pascal, and MASM /mx to preserve case. As Pascal doesn't add the underscore (or the type information), I must construct the mangled function name myself. (At one time I had hopes of writing

Much of this information was obtained from hours of studying disassembled code with a debugger

a general purpose macro to mangle the name for me, but gave up when it proved easier to cut and paste from the MAP file.)

Using Parameters

Inside the assembly function, value parameters can be accessed by using the name given in the PROC statement. The only exception is chars; you can get to them with, eg, byte ptr c. This overcomes the fact that chars are declared as WORD in the parameter list to keep the stack aligned properly.

Pointers are just a special case of value parameters. The 'value' of the parameter is an address which points to the real data. To reach that data, you dereference the pointer. InBytes and OutBytes give good examples of that - load the address into a register and grab the data using register indirect addressing (for Small and Medium models):

```
MOV DI, vals
MOV AL, [DI]
```

or (for Compact and Large models):

```
LES DI, vals
MOV AL, ES:[DI]
```

References are really just pointers in disguise - an address that points to the data. In assembly, you can declare and use them just as if they were pointers. Arrays are also passed as a pointer to the first element of the array.

A Non-member C++ Function

Figure 3 shows an assembly function written to conform to the Zortech C++ linking convention. Because it isn't a member function, InBytes contains no class name in the mangled function name. The section of the mangled name following the double underscore tells us that InBytes is a near function taking an int, a char*, and another int as parameters. Notice that we had to add the leading underscore ourselves, as MASM only adds it when using C linkage.

While OutBytes could be assembled for a different memory model with no change (except for giving the memory model in .MODEL), InBytes must have a new

```
; DISP2.ASM - ASM member functions of class Disp
; masm /mx disp2;

.MODEL SMALL, PASCAL

; asm equivalent of class Disp
Disp STRUC
    row    dw ?
    col    dw ?
    attrib dw ?
    height dw ?
    wid    dw ?
    base   dd ?
Disp ENDS

; for accessing the high and low words of a dd
Long STRUC
    Lo    dw ?
    Hi    dw ?
Long ENDS

.CODE
;;
;; void Disp::At(int r, int c)
;;
_At_4DispNii PROC USES SI, r : WORD, c : WORD, this : PTR Disp
    MOV    SI, this      ; SI -> object of class Disp
    MOV    AX, r
    MOV    [SI].row, AX   ; save to object
    MOV    DH, AL         ; into reg for INT 10h

    MOV    AX, c
    MOV    [SI].col, AX
    MOV    DL, AL
    MOV    AH, 2          ; position cursor
    MOV    BH, 0          ; page 0
    INT    10h
    RET

_At_4DispNii ENDP

;; void Disp::Put(char c)
;;
_Put_4DispNc PROC USES SI DI, c : WORD, this : PTR Disp
    MOV    SI, this      ; SI -> object of class Disp
    LES    DI, [SI].base ; ES:[DI] -> screen
    MOV    AX, [SI].row   ; base + (row*wid) + col
    MUL    [SI].wid
    ADD    DI, AX
    ADD    DI, [SI].col
    SHL    DI, 1          ; adjust from byte ptr to int ptr
    MOV    AX, [SI].attrib
    MOV    AL, byte ptr c
    STOSW
    MOV    AX, [SI].col   ; set to next column
    INC    AX
    CMP    AX, [SI].wid   ; check for right margin
    JAE    DP_99
    MOV    [SI].col, AX
DP_99:
    RET
_Put_4DispNc ENDP

END
```

Figure 4 - Two member functions with C++ Linkage

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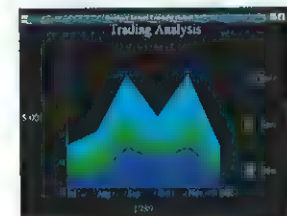
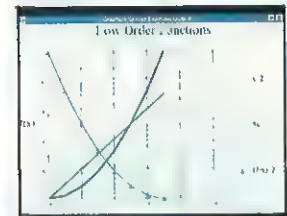
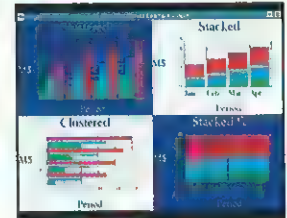
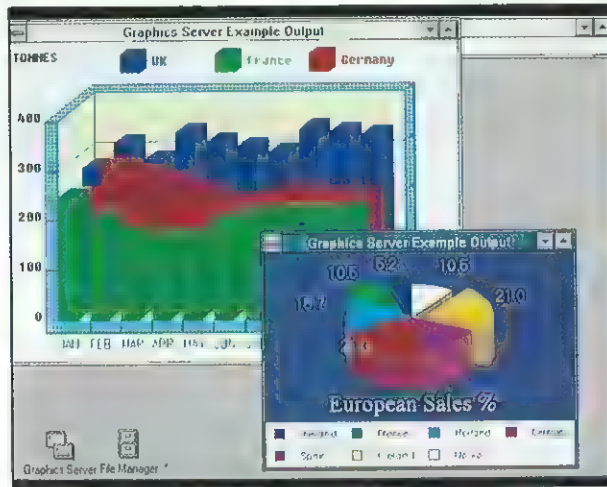
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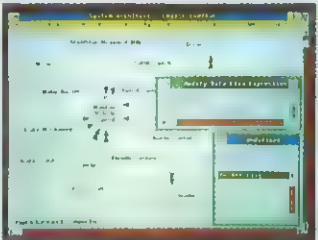
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name when the model is changed. Medium or Large model will require the 'N' (near function) to be changed to 'F' (far function), while Compact or Large will necessitate changing the 'p' (near pointer) to 'P' (far pointer). This might seem like a nuisance, but it can save your life. Having the 'distance' of pointers encoded into the function name means that you will never accidentally link in a function compiled for the wrong memory model.

The clause 'USES DI' in the PROC statement tells MASM that it should PUSH DI on entry to InBytes, and POP DI before exit, preserving the original value. Never change the values of the SI, DI, BP, SP, DS, or SS registers without saving them first. Other registers can be changed without worry, as the compiler does not assume their values will be preserved across function calls.

Member Functions

Aside from the addition of the class name to the mangled function name, the only

difference between a normal C++ function and a member function is the presence of the `this` pointer. `this` points to the object for which the member function was called; all accesses to the data members of an object in a member function are through `this`.

Zortech implements `this` as a hidden last parameter. Thus, a member function with the following prototype:

```
void Disp::Put(char c);
```

could be thought of (in terms of parameter passing, **not** naming) as:

```
void Put(char c, Disp *this);
```

(The Zortech V3.0 manual incorrectly states that `this` is a hidden first parameter. Believe me, it is the *last* parameter.)

To access the data at `this`, add another parameter to the end of the PROC declaration:

```
_Put__4DispNc PROC \
    USES SI DI, \
    c : WORD, \
    this : PTR Disp
```

(note that I declared `c` as a WORD rather than BYTE, because `char` parameters are passed as a word to retain word alignment on the stack.) The above *almost* works. The only problem is that, in MASM, `this` is a reserved word. In my programs, I always call it 'thiss' instead.

Data Members

'thiss' points to the first data member of the object. To use the other data members, you must make a STRUC with the same fields as the data fields of the class. You can then access the data by loading the pointer in `thiss` into an address register and using the fields of the STRUC as offsets from that address. For example, to get to the height member of `Disp` (Figure 4), use:

```
MOV SI, this
MOV AX, [SI].height
```

in Small or Medium model, and

```
LES SI, this
MOV AX, ES:[SI].height
```

in Compact or Large model.

// DISP.H - definition of class Disp

```
typedef unsigned char BYTE;
typedef unsigned int WORD;
```

```
class Disp
```

```
{
protected:
```

```
    int row, col;           // current row and column
    WORD attrib;           // colour to use when outputting
    int height, wid;       // size of display
    WORD far *base;        // ptr to 1st char of display
public:
    Disp();                // open display
    void At(int r, int c);  // position cursor at row=r, col=c
    void In(BYTE f, BYTE b) // set colour for writing
        { attrib = (f << 8) | (b << 12); }
    void Put(char c);       // put c at current position
    void Puts(char *s);     // put s at current position
}; // class Disp
```

// end of DISP.H

// DISP.CPP - members of Disp implemented in C++

```
#include <dos.h> // for REGS, int86, MK_FP
#include "disp.h"
```

```
Disp::Disp()
{
    REGS reg;
```

```
    // learn the current video mode and width
    reg.h.ah = 15;
    int86(0x10, &reg, &reg);
    base = (WORD far *) MK_FP((reg.h.al == 7) ? 0xB800 : 0xB000),
    0);
    wid = reg.h.ah;
```

```
    // EGA and above store (height-1) at 40:84h
    height = *((BYTE far *) MK_FP(0x40, 0x84)) + 1;
    if (height < 25) height = 25;
```

```
    // find initial cursor position
    reg.h.ah = 3; reg.h.bh = 0;
    int86(0x10, &reg, &reg);
    row = reg.h.dh;
    col = reg.h.dl;
    In(7, 0);
} // Disp::Disp()
```

```
void Disp::Puts(char *s)
```

```
{
    char ch;
    while (ch = *s++) // get characters until 0
        Put(ch);
} // Disp::Puts()
```

```
#if defined(NOASM)
```

```
    // C++ versions of assembly functions
    void Disp::At(int r, int c)
    { // position the cursor to row r, col c
        row = r; col = c;
        REGS reg;
        reg.h.ah = 2;
        reg.h.bh = 0;
        reg.x.dx = (row << 8) + col;
        int86(0x10, &reg, &reg);
    } // Disp::At()
```

```
void Disp::Put(char c)
{ // put the character c at current position
    WORD far *pos = base + (row * wid) + col;
    *pos = attrib | ((BYTE) c);
    if (++col >= wid)
        col--;
} // Disp::Put()
#endif // defined(NOASM)
```

// end of DISP.CPP

// DISPTTEST.CPP - test the Disp class

```
//
// ztc disptest disp disp2 - to test with ASM functions
// ztc -DNOASM disptest disp - to test w/o ASM functions
//
// note that ztc will call MASM /mx for given ASM files
//
#include "disp.h"
```

```
int main()
```

```
{
    Disp mono;
    mono.At(20, 5);
    mono.Put('X'); mono.Put('Y');
    mono.At(4, 15); mono.In(0, 7);
    mono.Puts("This is an entire string.");
    return 0;
}
// end of DISPTTEST.CPP
```

Figure 5 - DISP.H, DISP.CPP, and DISPTTEST.CPP

Be careful when constructing the `STRUC` that you match the layout of the class exactly. Pay attention to the size of each element (ints are 'DW', longs are 'DD', data and code pointers are 'DW' or 'DD' depending on memory model). Remember that, unless you use the `-a` compile switch (or the `align #pragma`), all data members except `char` are aligned to a word (even byte) boundary. The safest way to determine the offset of each data member in the class is to write a program which subtracts the address of the start of an object from the address of each its members and displays the results. For example, to find the offset within the class of `Disp::col`, use:

```
Disp t;
printf("%d", (long)&t.col
        - (long)&t);
```

Don't forget that some variables change size with different memory models.

Figures 4 and 5 give a complete example which implements the `Disp` class. `Disp` implements basic positioning and output functions for the PC display, taking into account the screen dimensions reported by the ROM BIOS. Two of the member functions are implemented in assembly (`At`, `Put`), while the others are in C++. Writing just these two short functions in ASM saved 81 bytes, according to the MAP file and my arithmetic.

You will get two warnings when you compile this example. Don't let either one bother you. One is warning about an assignment inside a `while` statement, the other about type-casting a `WORD` parameter to `BYTE`.

Calling Member Functions

After understanding all the above, calling a member function from assembly should seem trivial. Just push the arguments to the stack, left to right, with a final push of `this` just before calling the function which, by the way, has a funny mangled name. To call `Disp::At(4,10)` (from within another member function of `Disp`), you would use:

```
PUSH 4 ;assumes 286
PUSH 10
PUSH this
CALL _At__4DispNii
```

With memory models other than `Small`, you need to adjust some things accordingly. In particular, `Compact` and `Large` models require that you push both the offset and the segment of `this`:

```
PUSH this.Hi
PUSH this.Lo
```

Virtual Member Functions

If the function you are writing will be called as a virtual member function, you need change nothing; the address of your function will be entered in the virtual tables automatically. If you want to call a virtual member function from your assembly function, it's not so easy.

Briefly, the addresses of all virtual functions are kept in a table which is stored at the address given by the final word (`Small`, `Medium`) or `dword` (`Compact`, `Large`) of the object data. The virtual function pointer table consists of word (`Small`, `Compact`) or `dword` (`Medium`, `Large`) pointers to the proper functions for this object. The first word (or `dword`) of this table seems to always be 0, while the following entries are the addresses of the virtual functions for this particular object, in the order they are encountered in the class declaration (see Figure 6). For example, if `Disp::Put` was a virtual function (and the first virtual function of `Disp`), you could call it in `Small` model (after pushing the argument and `this`) with:

```
MOV SI, this
MOV BX, [SI+size Disp]
CALL [BX+2]
```

The second virtual function would be called as `[BX+4]` (again, for `Small` model), and so on.

If you really want to get involved in something so scary, check it out with a debugger first. My advice is to avoid it unless absolutely necessary, and if you really do need to call virtual members from assembly, don't believe anything you read in a magazine - research it for yourself.

Be careful that you don't call virtual functions directly from assembly - call them indirectly through the virtual function table if you must call them at all. Direct calling may work as long as all objects are of the class you have defined. But just let someone inherit your class into a new class and redefine the virtual function. Pow! the new class doesn't work because the members of your base class are hard-coded to call the base class function, rather than calling through the virtual function table.

Dangers

Some practices are almost guaranteed to cause problems. The most obvious is calling `inline` member functions. As these functions don't really exist anywhere, you can't call them from assembly.

It is also probably best to avoid using assembly for functions that return any

structs or classes, as the methods by which this is done are not standardised.

Finally, constructors and destructors contain lots of magic code. Never attempt to write a constructor or destructor in assembly!

Using Turbo C++

Turbo C++ brings even more complications to the writing of member functions in assembly. First, the names are mangled differently (as outlined in *.EXE February 1991*). Just to make you sweat, Borland's utilities un-mangle the names before putting them in the MAP file, requiring you to either search through a hex dump of the OBJ, or construct the names yourself, according to the rules.

Second, although Turbo C++ uses C parameter passing (push the rightmost parameter first, caller cleans the stack), the mangled names have no leading underscore. The lack of underscore prevents us from using `.MODEL C`, but when we use `.MODEL Pascal`, `RET` instructions are always assembled to clean the stack!

My suggested solution to this mess is:

- Use `.MODEL Pascal`.
- Construct the name by hand, or write a program to do it.
- List the parameters in reverse order (with `this` at the end).
- Instead of `RET`, use `RET 0` to force vanilla `RET` instructions (which don't clean the stack).
- If you call a C++ function from within your assembly code, don't forget to clean the parameters from the stack when you're done (with, eg, `ADD SP, 2`).

Conclusion

Although fraught with perils, writing member functions of C++ classes in assembly language is possible. In return for the extra work, you get smaller, faster programs, and a better understanding of how your compiler works.

EXE

Laine Stump was born near Yellowstone Park in Cody, Wyoming (the North-western US) and has been living in Turkey for the last six years. He currently teaches assembly language and C++ courses at Bilkent University in Ankara, Turkey, where he lives with his wife, Ayfer, and cat, Mahmut.

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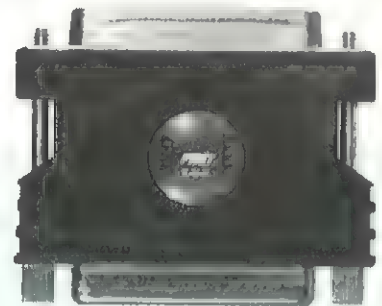
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Upper, Middle or Working Class?

The current trend for OOP and GUIs has given birth to a host of C and C++ class libraries to aid the budding GUI programmer. Paul Kemp and Cliff Saran check out the main contenders.

Everybody's doing it. Graphical front-ends are *de rigueur* - but as one look at a PM or Windows programming manual will tell you - it's not easy. More and more programmers are being asked for pretty, user-driven interfaces to their applications, forcing them to get to grips with often bewilderingly complex APIs. Portability becomes a major problem as a larger proportion of an application's code becomes 'Presentation System' specific. Developers that have invested a great deal of programmer time and money into creating applications with a fancy GUI understandably want their products to be available on as many platforms as possible, while keeping port-related coding changes to a minimum.

The adoption of object-oriented techniques to tackle these problems would seem to be

a panacea - by burying platform-specific code inside class implementations or C functions, the programmer is shielded from the messy details of the underlying API thus creating programs that are more concise, readable and, in theory, platform-independent. Since event-driven windowing environments map fairly well on to the OOP model (with messages passing between window 'objects'), toolkit vendors have been beaver away and released a number of C++ class libraries and 'object-oriented' C libraries to ease the pain of GUI programming. In this article we survey some of the current offerings.

CommonView

Veteran Hibernian OOPer John Carolan and his merry band of object wizards at Glockenspiel were the first outfit to exploit the nascent

market in OOP utilities. Their C++ compilers have been available on a wide range of platforms for some time, so they can justifiably claim to have a deal more experience in this arena than other suppliers. Glockenspiel's main aim in writing the CommonView C++ class library was to provide a genuinely portable object-oriented application framework. Its commitment to this rigorous design criterion is reflected in the somewhat limited range and functionality of classes in the CommonView hierarchy. For example there is no explicit Clipboard, Timer or DDE support because such facilities are too platform-dependent to warrant inclusion in the library. This approach appears to have paid off however and at the moment CommonView is available on a number of platforms: Windows, OS/2 PM and OSF/Motif with HP support in the pipeline.

The CommonView package actually consists of three main component hierarchies: FreeStore (memory allocation), Container (arrays, tables, lists etc.) and CommonView itself - the GUI library. The latter comprises some 60 standard GUI object classes such as DialogWindow, Control and Menu. Event handlers, in the form of virtual member functions of the Window class, are provided to trap the most common message types in an event-driven system (eg `Expose()`, `Resize()` etc) which simply need to be re-implemented if your application wishes to process these messages. If you need to handle messages like `WM_TIMER`, for which there is no event handler, it is necessary to override the `Dispatch()` method of Window and interrogate the raw Event object received to determine the actual message ID and associated parameters.

Extending the functionality of the CommonView hierarchy by writing platform-

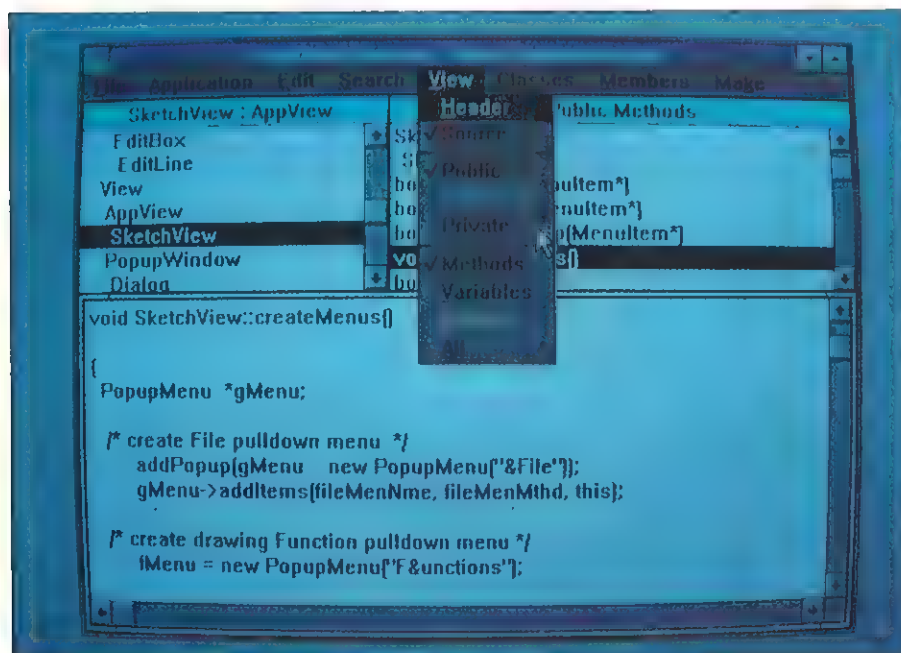


Figure 1 - The C++/Views Class Browser

specific code (which you will almost certainly have to do at some point) is achieved by obtaining hooks into the underlying presentation system through invocation of the `Handle()` method of classes such as `Window` and `Menu`. This returns a generic `CommonView HANDLE` which must be cast to the appropriate data type (such as an `HWND` in PM) for use in an API call. 'Kickdowns', as they are known, should of course be avoided if possible, as they compromise the portability of your code.

`CommonView` is a robust, no-frills framework which, because of its ascetic modular design, should be (if you're careful) portable and *interoperable* - ie easy to integrate with other third party libraries. Nearly all the classes are implemented in DLLs, so porting and upgrading is simple and the executables are small and efficient.

CommonView for Windows 3.0 costs £395, requires the Borland, Zortech or Glock C++ compiler and the Windows SDK (except if you're using Borland's C++ 2.0 for Windows). OS/2 PM version also costs £395 and supports the Zortech or Glock compiler and requires the PM SDK. OSF/Motif versions range in price from £1,470 to £9,450 depending on the platform. Contact QA Training Tel: 0285 655888 or Glockenspiel in Dublin on 010 353 1 733166.

C++/Views

Unlike `CommonView`, `C++/Views` from CNS Inc is a cosmic GUI class library. This means that all of the 75 or so classes provided in the hierarchy are derived from an ancestral generic `Object`. `C++/Views` also differs from `CommonView` in that it is bundled with a number of utilities, and on initial inspection seems to provide a greater range and functionality of objects. Both foundation and framework classes are built into the library, including an `Archiver` class which implements the persistence of objects by providing a mechanism for object storage and retrieval on disk. The product is mainly aimed at improving the productivity of Windows 3.0 developers and only supports that platform at present (PM, Motif and Mac variants are purportedly on their way before the year's end).

`C++/Views` implements what is known as the 'Model-View-Controller paradigm' or MVC (CNS's words, not mine). The general idea here is that the separation of an application into these three interchangeable layers provides for greater portability - for instance you just plug in a different View layer for each presentation system (isn't that what OOP is all about anyway?). The *Model* layer is where application-specific

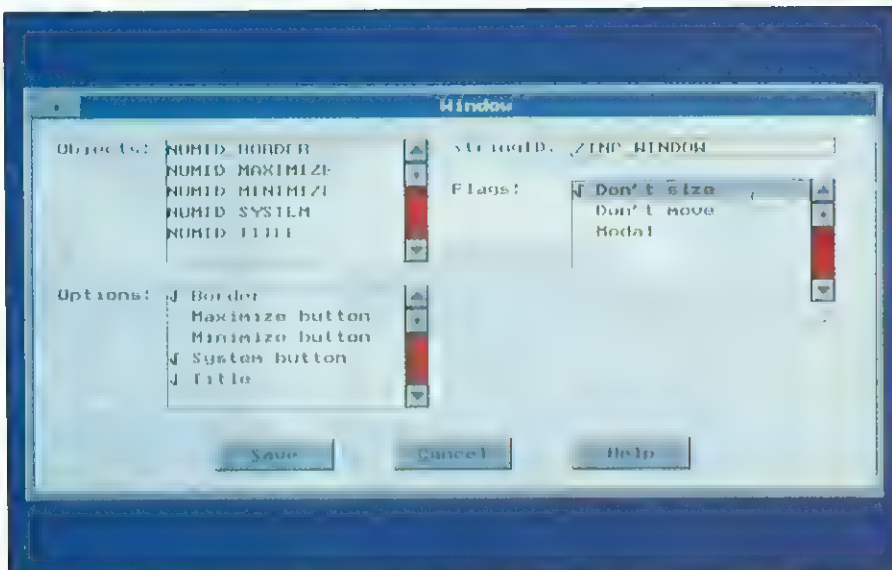


Figure 2 - Interactive screen design using Zinc's Windows Editor

classes sit. They are usually written by the development team and may use foundation classes and/or add-on classes for tasks such as database access. The *View* layer implements the graphical elements of the application (hence `C++/Views` geddit?). These objects extract information from the model layer and present it to the user (in graphs, lists etc). At the top sits the *Controller*. Objects in this layer supply the interface between input devices (eg mouse, keyboard, timer) and the model and view layers. The controller layer of `C++/Views` consists of only one object class called the *Notifier*. It has application scope, is instantiated only once and serves to initialise the windowing environment for event processing (`Notifier's start()` method is analogous to the message polling loop in `Windows` or `App::Exec()` in `CommonView`).

There are a couple of handy development tools included in the `C++/Views` package: a Smalltalkish Class Browser and a Dialog Code Generator. The browser is a Windows program that can be used to maintain and document the classes used in an application (see Figure 1). The Dialog Code Generator is an interesting program which reads a .DLG file created with the SDK dialog editor and generates a skeleton C++ source file to implement the design.

All in all, `C++/Views` provides a fairly comprehensive and extensible framework for Windows development. However, because the library is not supplied as a DLL, upgrading and porting will require at least relinking and executables don't come any smaller than about 100K. Another worry is that because of its cosmic inheritance tree it may prove difficult to use with other cosmic libraries.

C++/Views for Windows 3.0 is supplied with complete source code, requires the Windows SDK and costs £200 + VAT if you're using the Zortech C++ compiler. Zortech distributes its version in the UK and are on 081 3167777. For prices of C++/Views which support the Glockenspiel and Borland compilers contact CNS on 010 1 612 9440170.

TIER

The TIER C++ class library from Genesis Development Corp was written by one Carl Sturmer and was not initially designed to be marketed as a product. It was used as an internal development tool by the Sturmer Hauss Corporation to aid the creation of commercial GUI applications before they decided to tart it up and flog it as an application framework. By the company's own admission it has, up to now, been sold pretty much by word of mouth and as yet there is no UK distributor.

Like `C++/Views`, TIER has a layered or *tiered* architecture: *TIER 1* is the C++ interface to the base platform primitives (this is currently available for Windows 3.0); *TIER 2* consists of a more generic set of higher level 'helper' classes and *TIER 3* is a totally generic, platform independent programming environment. While conceding that portability is important, Genesis also recognises that programmers who are writing serious Windows applications need access to the base platform functions. Consequently, code written using TIER 1 classes has a degree of platform dependence (since this layer will look slightly different for each target GUI).

The hierarchy is not cosmic but most of the classes are derived from `T1Object`, so it can be considered something of a half-

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way-house. The design of the classes themselves also appears to be something of a C/C++ hybrid. There are no event handlers or interaction objects (as in CommonView) and most of the methods look like Windows/PM API calls. This approach is deliberate, as TIER was designed to allow access to low-level functions and not 'fight' with the Windows C API. It does mean however that it doesn't use as many object-oriented features as other libraries and I suspect that there are not many benefits to be had from code reduction over a standard Windows app, although maintainability would be enhanced.

Because it is not doggedly committed to platform-independence, TIER 1 provides a

very impressive array of 115 GUI classes. All Windows 3.0 functionality is encapsulated including the full complement of GDI graphics functions, so there should be no need for kickdowns. My feeling is that TIER might be a good library to choose if you are already a pretty competent Windows programmer wishing to move to C++ without losing any control over exactly what is going on below the OOP bedsheets.

TIER 1 for Windows 3.0 is currently on special offer at \$199 + shipping (Air Mail \$20, Courier \$66) and includes support for Glock, Borland and Zortech compilers. The Windows SDK and a C++ compiler are required. Source listing costs \$495. It is available direct from Genests, 1303 Columbia

Dr. Suite #209, Richardson, Texas 75081. Tel: 010 1 214 6448559 or fax: 010 1 214 6444286.

GUI_Master

Dutch software house Vleermuis is the originator of GUI_Master, a sophisticated object-oriented toolkit for developing Windows and PM applications (OSF/Motif should be available in December '91). The product is composed of three main parts: The Interface Builder, The Browser and The Vleermuis C++ Class Tree.

The Interface Builder is essentially a screen painter++. It lets you construct windows and dialog boxes on the screen and then generates C++ source code and resource specifications to implement the design. The Class Browser is another Smalltalk-like application similar in appearance to the C++/Views browser. It allows you to locate methods and classes and associate them with the source files that implement their behaviour. From here you can also launch your favourite editor to modify the code if necessary. The class tree is cosmic and pretty extensive, with 85 objects which implement the GUI plus some extra goodies that augment the functionality of the basic Windows/PM SDK. These include facilities for data scrolling in windows; undo-redo; clipboard support; pre-defined standard dialogs (such as 'Open', 'Save' and 'Font'); printing; archiving (persistence) and run-time error handling.

Vleermuis has big plans for the future of its C++ product family with several new libraries/toolkits currently under development. The first, DRAW_Master (a generic drawing program for the development of graphics applications), is in beta test at the moment and scheduled for release in September of this year. Other utilities in the pipeline are DATA_Master (an object-oriented shell for SQL databases); MATRIX_Master (for spreadsheet apps); QUIZ_Master (*sic* - for rule-based apps); AD/CYCLE_Master (to help build CASE tools that interface with IBM's repository) and COMS_Master (which implements mixed-vendor program to program communication). All these products will be shipped in source code format. GUI_Master looks like a well integrated GUI development environment but, as with a number of other libraries we have looked at, once you start down the Vleermuis track you might find it difficult to change course when new horizons beckon.

GUI_Master requires the Windows/PM SDK and a C++ compiler - Glock, Zortech or Borland (Windows only). Single user

Astronomical Jargon

Foundation Library - a set of classes that implement basic programming objects like strings, arrays and streams. Abstract classes may also be supplied that define common behaviour when copying and comparing objects derived from the same parent.

Application Framework - a class hierarchy that is concerned with building an application's user interface (like the ones discussed in this article). Typical objects include windows, menus, buttons and some kind of event handling system.

Add-on Classes - eg. third-party libraries to support things like databases, specialised graphics, comms etc.

Application Classes - these are designed and implemented by the developer and are specific to the application being written.

Cosmic vs Non-cosmic - CommonView is described as a *non-cosmic* class library. This means that it is made up of independent component hierarchies, each one concerned with a specific task: memory allocation, user interface management, object storage etc. Libraries such as C++/Views and Win++ are *cosmic* because all objects are derived in Smalltalk fashion from a single parent class (usually called something like 'Object'). The Object superclass provides generalised methods for such things as comparing, cloning and archiving objects which are its descendants (subclasses). This would seem like a good idea except that, as Glockenspiel's John Carolan points out, there are a number of problems:

In the absence of an industry-standard set of foundation classes, some third-party vendors are supplying their own implementations of fundamental objects such as strings, streams and arrays. This can lead to chaos with name-clashes and parameter incompatibility when one tries to use two or more cosmic libraries within the same application (needless to say Glock's CommonView does not suffer from this problem and has, we're told, been tested successfully with C++/Views, RogueWave and Microsoft's AFX).

Secondly there is an overhead in terms of the amount of static data within an application, since *all* classes inherit Object's data and methods. Developers can also come unstuck if the vendor who supplied their cosmic class decides to change its implementation or design since all their application classes are dependent.

Finally, the use of a cosmic superclass affects the link characteristics of a program so that (when using a standard linker) all virtual functions appear in the executable, whether they are called or not, resulting in bulkier .EXE files. Perhaps with the advent of Microsoft C++ and its attendant cosmic foundation library a *de facto* standard will emerge to dispense with many of these universal problems.



licence for PM costs \$495 and \$545 for Windows. Site licence (combined PM and Windows) costs \$4,950. Full non-competitive source code licence is priced at \$50,000. Vleermuis is based in Utrecht on 010 31 30324944.

Zinc Interface Library

The Zinc Interface Library (ZIL) is a C++ class library that allows the applications programmer to create a professional GUI without having to resort to using Microsoft Windows. Both Windows and DOS based versions of the library are available. In fact, only minor modification of the source code is required to convert an existing DOS application to Windows. With C++ finding a new niche with developers of Windows applications, it's nice to see a GUI class library that supports both platforms. There are separate versions of the library providing support for both Borland's BGI graphics routines and Zortech's Flash Graphics routines. For those of us who can't afford trendy graphics displays, there is even a text-only mode of operation.

Conceptually, the ZIL can be divided into three main sections. The event queue provides the backbone of the system, with all events and interrupts being governed by the Event Manager class. User input is processed through Zinc's event queue before being passed onto the Window Manager class. This, in turn, controls windows and window objects by monitoring their priorities and screen positions. Operations like cutting, pasting and copying are handled automatically by the Window Manager. The final section contains all of those special features that complete the picture; there are classes for 'help' and error handling and for mapping of the palette. The Event Manager is capable of determining the attached display type automatically, and it is even possible to switch between a text-only and a graphical user environment at run-time. Consequently, an application can be written generally, without regard to any given display adapter.

To simplify the creation of application screens, the ZIL is packaged with the Zinc Designer (see Figure 2). This is an interactive design tool that enables screen layouts to be saved to disk as objects. These may be later retrieved using a single line of code.

The DOS version of the Zinc Interface Library costs \$199.95 and \$249.95 with source code. The Windows version also includes the DOS library and costs \$299.95 and \$399.95 with source code. ZIL is distributed in the UK by Zortech on 081

3167777. For more information contact Zinc Software Incorporated, 405 South 100 East 2nd Floor, Pleasant Grove, Utah UT 84052, tel 0101 801 7858900.

TEGL WINDOWS TOOLKIT II

TEGL Systems Corporation also ships a DOS base GUI library. At present, only C and Turbo Pascal versions of the library are

A GUI class library is just providing an object-oriented interface to the API beneath

available, but TEGL is working on an object-oriented version, which is expected to be released in August and this will be available as a free upgrade. The TEGL WINDOWS TOOLKIT II is supplied with a GUI library, a memory manager and a windows manager. There is no need to purchase a separate windowing environment or to use third party memory management software.

The TGI graphics library is a go-faster version of Borland's BGI library. TEGL claims that its library runs between two to three times as fast as Borland's BGI. This is not surprising since the TGI is written in assembler and accesses video hardware directly. The TGI contains video drivers for CGA, EGA, VGA and Hercules graphics, and it also supports SVGA. The library may be used completely independently of the memory manager or windows manager.

As with Zinc's offering, TEGL's windows manager is event driven. Only a drawing event for a specific window object needs to be coded, as resizing of windows is done automatically. It is entirely possible to create an application based on a completely customised GUI and all the main windowing structures have been built into the library. Scroll bars, window borders and headers have already been defined, providing a rapid method of generating user friendly front ends for applications.

The TEGL Windows Toolkit II is supplied with an icon editor, more than 40 bit-

mapped fonts and a font editor that can be used to create fonts as large as 100 x 100 pixels. There are versions of the library available for Turbo Pascal and C, with the C version supporting Turbo C/C++, Quick C, Microsoft C and Watcom C.

The complete TEGL Windows II package costs \$99 and includes the complete source code. For more information contact TEGL SYSTEMS CORPORATION, Suite 780-789, West Pender Street, Vancouver, British Columbia, Canada V6C 1H2, tel 0101 604 6692577.

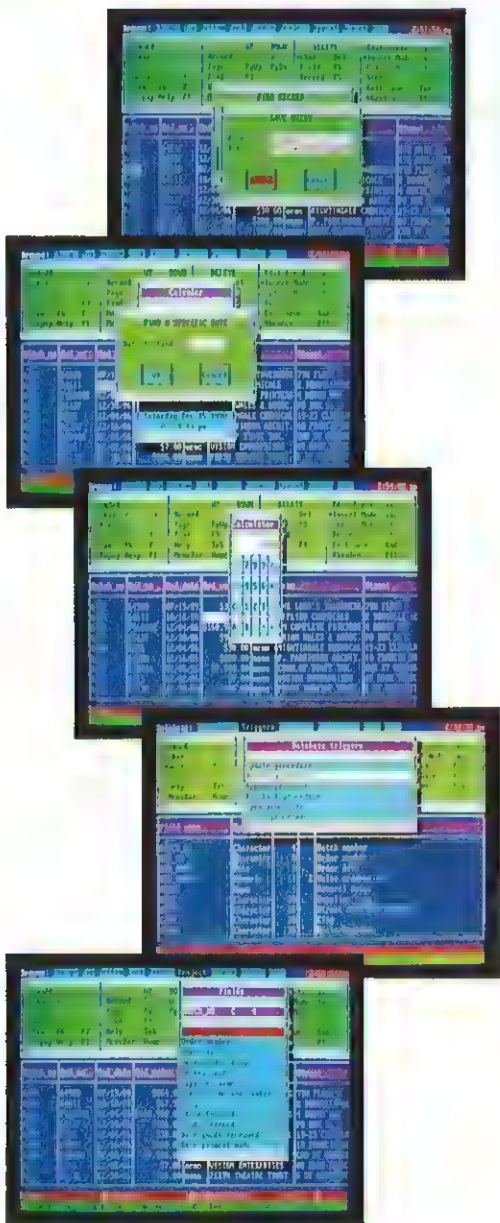
XVT

The Extensible Virtual ToolKit (XVT) is a GUI library that provides a portable interface for programmers who are developing applications intended for a multitude of platforms. At present the library is available for OSF/Motif, OPEN LOOK for X Windows, Microsoft Windows, Presentation Manager and the Macintosh (see Figure 3). There is also a text-only windows manager. Identical source code runs on all the above platforms, illustrating the versatility and the rugged design of the XVT library.

There are two versions of the library available; the C version (XVT) is totally compatible with ANSI C, and the C++ version (XVT++) supports AT&T's C++ V2.0. XVT is also planning on supporting Borland's C++ in a future release of the library. Superficially, it would seem that an object-oriented version of the library is actually available, but a closer look reveals that XVT++ is in fact providing an object-oriented front-end to the inner workings of the XVT interface underneath. There is a school of thought that states that a class library should be designed from the bottom up, adhering strictly to the object-oriented philosophy of programming in C++. On the other hand, a GUI class library is just providing an object-oriented interface to the API beneath. The XVT++ library is simply providing an additional layer of interface code to the API and as there is little performance penalty, using XVT++ to provide an object-oriented interface shouldn't really cause any headaches.

XVT does not include a design tool with its library but an interactive design tool and application generator is available as a separate package. XVT-Design is capable of generating GUI resources such as dialog boxes, windows, controls and menus which are portable and can be easily transferred across different platforms. It can also generate the C source for a framework application, including header files and the MAKE file.

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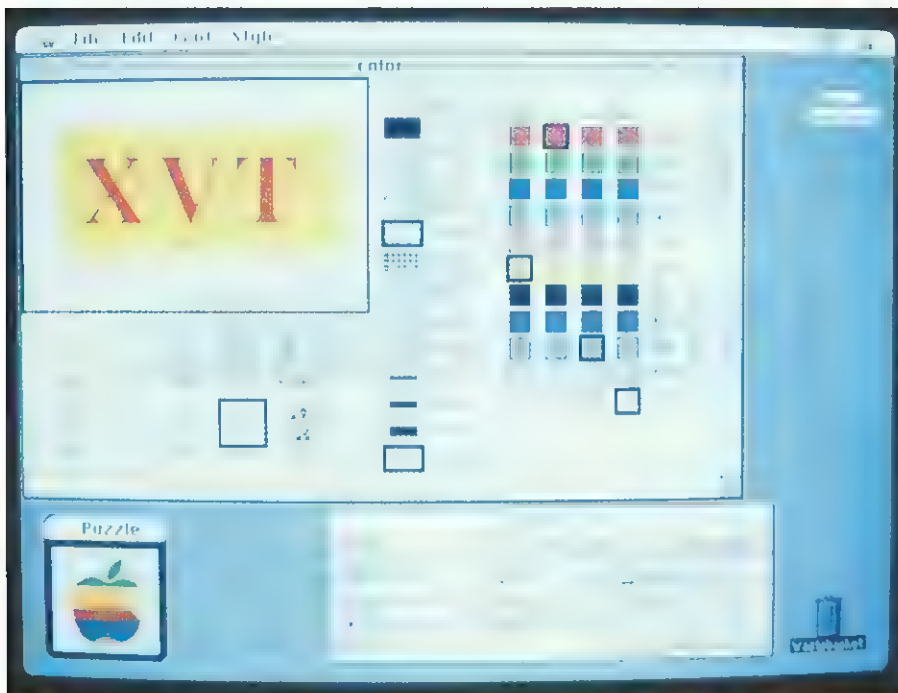


Figure 3 - An application using XVT on the Apple Macintosh

The XVT library for the Macintosh, OS/2 Presentation Manager or Microsoft Windows costs £545 and £3795 with source code. The X Windows version costs £995. Developers wishing to use a C++ GUI class library may purchase, for an additional £195, the XVT++ object-oriented interface to XVT, which will work on any of the supported platforms.

XVT-Design costs £595 for the Macintosh, Presentation Manager and Windows, and £1595 for the X Windows version. XVT is distributed in the UK by Personal Workstations Limited, 48-50 Gainsford Street, Bachelor's Wharf, London SE1 2NE and can be reached on 071 4036698.

Win++

Win++ is a C++ GUI class library that provides developers with a ready made environment for creating applications running under Microsoft Windows. Presently, Win++ only supports the Borland C++ V2.0 compiler. Most of the classes provide a straightforward, high-level interface to Windows. There are classes for all windowing objects and there are also container classes for handling such abstract objects as stacks and queues. Win++ is distributed in a number of formats including static-link and dynamic-link libraries. There is no need to purchase the Microsoft Windows Software Development Kit although it may be helpful, especially if there is even a remote chance that your application will need to be debugged...

Win++ provides a class for each type of display entity in the Windows environment. A base class exists for configurable objects and a number of derived classes are available for the most common types of Windows objects like dialog boxes. This provides a versatile method of generating objects. Instances of existing classes may be used to provide a quick method of implementing all the standard windowing features. A truly customised Windows object may be derived from the appropriate Windows base class.

Win++ does not provide an individual event handler for every possible event that could occur; instead there are a number of functions for supporting user-defined and other unsupported event types. There is also a function that handles the default action which can be used to provide a clean method of responding to an event before passing over control to the default procedure (eg trapping keyboard events).

Win++ costs \$249 and the price includes source code. It is available from Blaise Computing Inc, 816 Bancroft Way, Berkeley, California CA94710. Blaise can be contacted on 0101 415 5405441.

Coming Soon

Microsoft is being unusually candid about its eagerly awaited C++ compiler, which will probably be shipped as C version 7.0 before the end of the year. The package will consist of a fully integrated PWB-like C and C++ programming environment for DOS

and OS/2, with C++ support in the editor, a class browser and revamped CodeView debugger. The C++ implementation will be fully compliant with the AT&T 2.1 language specification, has been tested in-house for some time and is being used to develop the 32-bit graphics engine for Win 32 NT (due for release sometime next year).

Andrew King, Microsoft UK's Head of Languages, assures us that there will be extensive foundation and framework class libraries bundled with the product. These will be cosmic with all objects being derived from a superclass C_Object. Its 'AFX' GUI class hierarchy will only support Windows for the foreseeable future; the designers figure that if OS/2 2.0 runs Windows apps - why bother. If you are a faithful Microsoft disciple but just can't wait to get your hands dirty with C++, Microsoft suggests you get started with Glockenspiel's C++ and CommonView, as these class libraries are the nearest you'll get to what Bill's boys will be offering, and Glock code should be source-level compatible with the Microsoft compiler.

Borland's offering will be based on its Object Windows Library, which is presently only available for Turbo Pascal.

Conclusion

Including a GUI is not just a matter of adding the appropriate library and 'touching wood'. GUI-based applications tend to be notoriously power hungry; a static-linked library will add at least 100KB to the size of an application.

A 'turbocharged' workstation is normally required to run the application, but unsuspecting DOS users who may well expect the same application to run on their old IBM XT. Fortunately such end-users are few in number and have acquired the status of 'endangered species'.

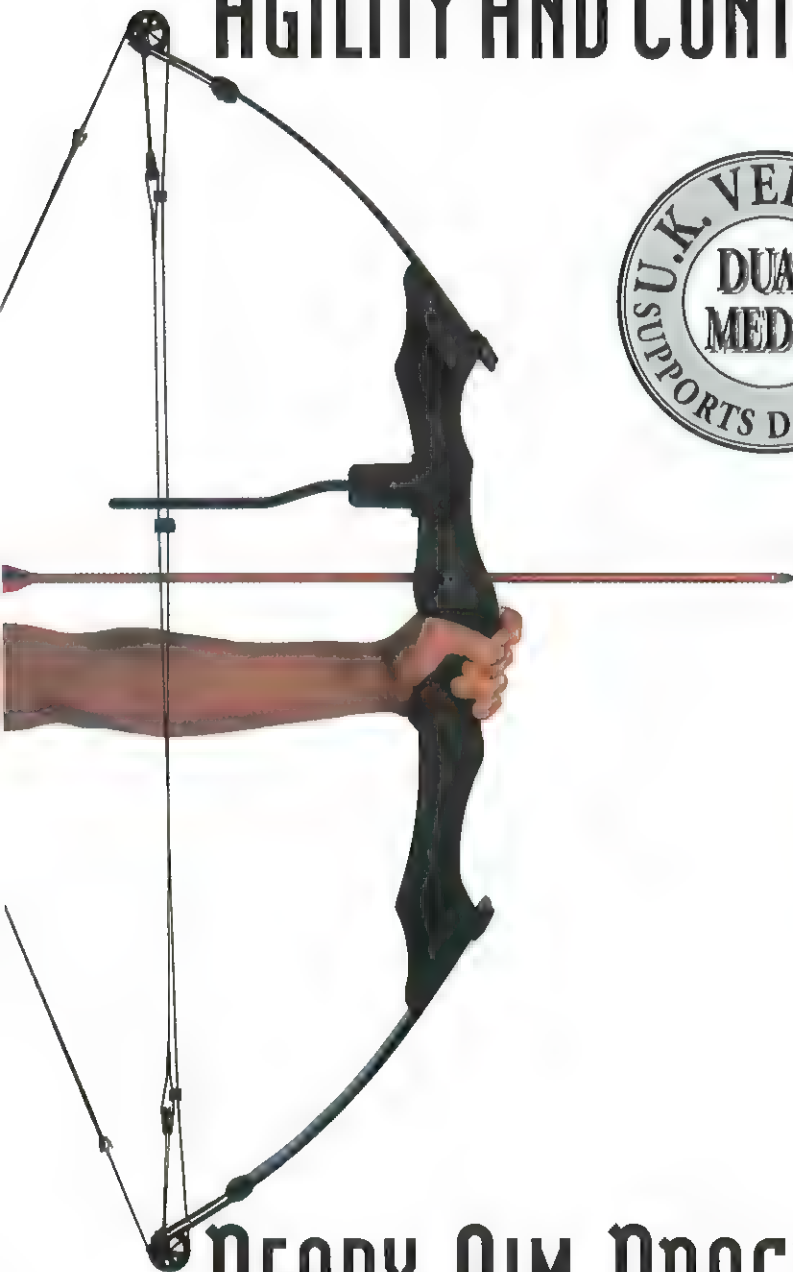
The GUI library is here to stay and the unwary software developer is already suffering from an embarrassment of choice. The rise in popularity of the GUI has started the ball rolling toward a new era in the design of more powerful, more friendly, end-user applications.





As a final word to you dinosaur software developers here's some sound advice, 'get on the bandwagon before it's too late!'

[EXE]


Paul Kemp and Cliff Saran are .EXE's latest luscious editorial acquisitions.

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He called me 'Squire'

If a prospective customer sends Darrel Ince round to check up on your software house, you'd better polish your design documents, clean up your quality control and hide the aquarium.

One of the most enjoyable parts of my job involves visiting software companies. I am normally called in by a customer who wishes to employ a software developer, but has insufficient expertise to judge whether the developer they wish to use is competent. My job is to write a report and advise them. The process of evaluating a software developer can, at most, take a day although there are quite a few software developers who I have visited where it is easy to come to a conclusion after about ten minutes.

I enjoy this work because you come into contact with many of the Arthur Daleys of the software world; indeed, many of the people I meet make Arthur look like a paragon of morality and competence. I remember visiting one company where the director wore a snappy suit, had a massive Rolex watch (I suspect it came from Hong

Kong) and smoked the size of cigar which you would associate with George Cole himself.

***The one slightly
heartening thing
for this country
is that the US
experiences are
much worse***

self. My visit was a remarkable one for reasons which will be obvious later in this

article, but also for the fact that it was the first time that I had been called 'squire' in my life.

I asked him my standard set of questions there are about 25 which help me judge competence, and his company failed the first 23. His stock responses consisted of variations on 'What's that squire?' or 'Never heard of that one squire'. My twenty-fourth question is about training, and is normally accompanied by a request to see the training records. My aim in asking this question is to see what sort of courses, if any, the company sends its staff on. Whether they are sensible courses on design, project management and quality assurance, or courses on bit-twiddling in C, advanced bit-twiddling in C and structured bit-twiddling in C. When I asked my question he got up and made for the door as if to retrieve the training records. I was astounded: he had failed the first 23 questions abysmally, and here he was about to show me the training records.

He returned with something of a sad look on his face. 'Sorry squire', he said, 'bit of a disaster, we normally keep our training records on the computer and it's just gone down'. Presumably because he had just phoned from his secretary's office, telling the boys to pull the plug pronto. I commiserated, and asked to have a talk with whoever was responsible for training, a training manager perhaps. A lesser man would have admitted defeat. Not him. He stood up and left the office looking for his 'training supremo'. I spent five minutes wondering what the excuse would be this time. Perhaps he would say that his training manager had died that morning, possibly in a heroic (but vain) attempt to mend the computer.

He came back with a young man - perhaps half my age - who looked very flus-



tered. After the introductions I asked him whether he supported the National Computer Centre's HeadStart scheme. He assured me that his was one of the few companies in the area which fully subscribed to the ideals of HeadStart, was deeply committed to playing a major role in the scheme and he, this very day, was to ensure that line management were appraised of the virtues of the scheme. I found his commitment to the HeadStart scheme impressive and moving, particularly since it was something I had dreamed up on the spur of the moment. Clearly, the manager had left the office and found the first gull in his company to act out the fantasy of being training manager.

Something Fishy

A remarkable thing about this company, and many of the poor companies that I visit, was that it had a fish tank in the foyer. It seems almost axiomatic that the presence of a fish tank indicates awful software development practices, so that should be the first thing that you look for. The aim of the rest of this article is to point out some of the more technical signs of software malpractice.

One of the most important features of a competent software developer is the effort that is put into the system specification and the process of constructing this document. The system specification is the key document on the software project: the designer uses it to produce a system architecture; quality assurance staff use it to derive the system and acceptance tests; the project manager uses it normally in outline form, to produce a costing for a project; and the technical authors use it to produce user documentation. Get the specification wrong and everything is wrong. There are a number of natural laws in this world, for example, the sun comes up in the morning and sets in the evening. There is also the natural law that if a sentence in a document is capable of being interpreted in n ways and n people read that document, then each will interpret the sentence differently. This means that a poor specification will give rise to a system which does not implement what the customer requires; which is validated by tests that bear little relationship to live data; that is produced by a project which goes over budget; and which is accompanied by user documentation that bears more resemblance to a work of fiction than a user-oriented view of the properties of the system.

A correct concern with the system specification manifests itself in a number of ways. The major indicator is that the software developer spends at least 20% of his resour-

ces in analysing and writing down user requirements. Another indicator is the degree to which validation occurs during the early stages of the project when the system specification is produced. If the developer uses a fourth generation language then prototyping should occur, and there should

***Someone who
bates the Project
Manager will
come up to me
later and say
'Psst, they are in
the cupboard'***

be technical meetings, such as reviews, to which the customer has been invited. The developer should also have a quality standard which insists that his staff produce the system tests as soon as possible after the system specification has been completed. There's nothing quite like the discipline engendered by a good tester looking over your shoulders at the system specification saying 'But how the hell do I test that?'

Beware, however, of the software developer who claims to use prototyping. One of the first questions I ask when visiting a dubious software developer is about the standards used for producing system specifications. A common answer to this question is 'We don't have a system specification guy, what we do is to produce the system and show it to the customer and then change it, and so on, until everybody is happy - it's a modern technique known as prototyping'. Beware of this attitude: it's just old-fashioned hacking masquerading beneath the fashionable garments of a modern technique. Even companies that carry out prototyping still produce a system specification after the prototype has been agreed with a customer; for one thing it is vital for maintenance.

A technique which I've found useful when asking questions of a rogue software developer is to wear a bow tie. It's also useful if you have some form of academic title such as 'Dr' or, even better, 'Professor'. It also helps to develop a distracted, rather abstract, academic air. In the early years of my marriage I de-

veloped such an air in order to avoid tasks which my wife assigned me, such as cleaning out the garage: 'Garage, garage, now where would I find that'.

The first thing that I do when visiting a suspect software company in a large city such as London or Manchester, is to admit to having major problems finding the city. Not the street in which the company is situated, or even the district, but the city. The look of relief that crosses the face of the staff that I meet, when confronted by a bow-tied academic who is incapable of finding a major conurbation is totally visible. They become relaxed, they make no effort to hide the various warts and carbuncles in their development environment, and assume that the absence of any standards, procedures and management practices will pass by a visitor who is clearly incapable of finding his way out of the building. It's only when you start quoting the page numbers of BS5750 and talking about NATO defence standards do they realise that instead of swimming with a rather amiable, distracted porpoise they have found themselves with a basking shark, but by then it's too late.

Independence

One set of questions that I ask a software developer concerns independent validation. That is, the extent to which the checking of a software product, a specification, a design or a software component is carried out by staff who have not produced the product, or who do not have a vested interest in the product passing a validation check. For example, many programmers do not like discovering errors in their code because it reminds them of their mortality. Consequently, the testing of subroutines or partial versions of a system is often skimmed. Also, managers are so obsessed with budgets and hand-over dates that activities such as system testing are badly skimmed. If a software developer uses independent validation teams, or insists that modules are tested by programmers who have not produced the module, then that is an excellent sign.

A bad sign is a flag flying outside the developer's building announcing the fact that the company has been given the Queen's Award to Industry. In my experience, there is no correlation between this and software competence. Indeed the reverse is often true. Certainly, if I see this flag flying outside a developer's building *and* a fish tank inside, then I know that it is not even worth my while asking any technical questions of the software developer.

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CIRCLE NO. 066

Life-cycle mantra

Another set of questions that I ask a software developer concerns change. Often I visit software projects and am shown around by a senior manager. He usually takes me to see some of the more prestigious projects that they are undertaking. When visiting a project which is in its last stages, say system testing, I usually ask the manager who on his staff is still carrying out requirements analysis. The answer is usually in the form of a mantra or chant: 'We are a company totally devoted to software quality assurance, we have a phased life-cycle model where our projects are split up into a series of distinct phases. Each phase delivers a document which then forms the input to the next phase, this subsequent phase then produces another document which again is passed on to the next phase and consequently no staff are involved in this activity'.

My reaction is to admire the ordered way in which the software projects are organised and then ask my question again. The answer I receive is: 'We are a company totally devoted to software quality assurance, we have a phased life-cycle model where our projects are split up into a series of distinct phases...'. However, I usually take the precaution of asking the question loudly, since there will often be a member of staff, usually someone who hates the project manager, who will come up to me later and say 'Psst, they are in the cupboard'.

They are in the cupboard for a number of reasons. The first reason is that software development is probably the most difficult task that we carry out. Consequently, errors are going to be made which only surface late in a project, and which require re-specification and redesign at quite a late stage in that project. Another reason is that for any project which delivers more than a trivial system, changes in requirements are going to hit that project almost from the first day on which the project has been set up: the project which delivers an accounting package will be affected by changes in tax laws, the project which produces a management information system will be affected by a new management team taking over in the customer's company and the defence system project will be affected by changes in the technological capability of a potential aggressor, whoever that is these days.

Because of the dynamic nature of software projects, the competent developer will have set up a formal system known

as a configuration management system which evaluates whether a change is necessary, sanctions the change, checks that the change has been correctly applied and then lets everybody know what has happened. This will avoid the major problems that, for example, be-devils American defence projects.

***Presumably he
had just phoned
from his
secretary's office,
telling the boys
to pull the
plug pronto***

Traceability

Another question I ask a software developer concerns something known as 'traceability'. I normally ask the developer to show me the program code for a system which has been completed. After admiring the programming standards I place my finger on a section of code, usually a subroutine or procedure if the language is a third generation one, and ask them which functions in their system specification that code helps implement. If they come back quickly, say in five minutes, and tell me, that for example, the code helps to support the updating of a sales order file and also supports the updating of a warehouse file, then the developer is very well organised. If it takes around an hour the developer is usually competent. Anything longer usually indicates incompetence. The response 'What's a system specification?' means that you have hit rock bottom.

Traceability is vital for a number of reasons. Let us examine one: that of rerunning acceptance tests. Acceptance testing is the process whereby the developer and the customer run a series of tests on a system which demonstrates that it actually meets the requirements of the user. Acceptance testing is one of the most nerve-racking activities on the software project, if anything goes wrong during this activity it can take a lot of resources to put it right. However, it is not unknown in the software industry for an acceptance test to fail. A responsible software de-

veloper will then try to discover what exactly has gone wrong, and modify the system to get rid of the problem. After rectification, the acceptance test is rerun to check that the modification to the system has been made. A poor developer will then carry on testing, so for example, if acceptance test 1228 has failed and been rectified, the developer will then execute acceptance test 1229. Wrong. If there is no traceability in the system documentation the testing has to start again from the beginning.

The reason for this is that in modifying the system in order for it to pass an acceptance test the programmer may have modified a module which is also executed by a previous acceptance test. Now, industrial studies have shown that making a modification to a system at a late stage in a software project is a risky business. The figures seem to suggest that a change applied late in a project only has a chance of being correct with a probability ranking from .2 to .5. The probability will depend on factors such as the competence of the programmer, the programming language used and the degree to which debugging tools were used. Even with all the factors favourable it seems that the probability of an error occurring will still be as high as .5.

This implies that a change to a system to make it pass a particular acceptance test will often mean that it could fail the series of earlier acceptance tests. In order to guard against this, a developer should keep track of which modules are executed when a particular acceptance test is exercised. This means that only those previous acceptance tests which involve the modified modules are rerun. If this traceability documentation is not kept, then all the acceptance tests have to be rerun. Indeed, I always advise clients who sign a software contract to put the phrase 'the customer reserves the right to ask for the full acceptance test suite to be run after a rectification following an acceptance test failure' in that document, it usually scares the hell out of the software developer.

This is just one reason for having traceability in the documentation used by a software developer. The software engineering text books describe many other reasons which, when added up, means that if traceability is not built into system documentation then a developer will experience major problems.

25 Questions

These, then, are some of the questions which I ask a software developer. As I



have said, I have a list of 25 and, on average, most competent software developers can answer 15 of them well. Unfortunately, something like 40% of the developers that I meet have a hard time in answering two or three correctly. The computing industry is relying more and more on consultants or independent validation organisations who use a standard set of questions to dig out any incompetence among software developers. The major player in this area at present is the American Department of Defense, which uses a questionnaire of about 65 questions to root out companies who should not be contracted by them. This questionnaire was developed after the American government discovered that out of all the software projects contracted by them only 2% of the software was used as delivered, with 47% delivered but never used and 30% paid for but not delivered.

The one slightly heartening thing for this country is that the US experiences are much worse than mine. Eighty-five percent of the companies they have surveyed in the defence industry have not

reached the barely adequate stage with only 1% of the companies wholly satisfying the surveyors.

It seems almost axiomatic that the presence of a fish tank indicates awful software development practices

The major experts on software capability assessment in the United Kingdom are housed in the Institute of Software Engineering, a government-funded body

based in Northern Ireland. They carry out a free assessment of your software capability based on a 60 point questionnaire which you have to fill in. They provide you with this assessment in terms of a points scoring system which tells you where you lie in a spectrum that ranges from 'appalling' to 'very competent'. Give them a ring or send them a letter, as part of their brief is to improve the capabilities of British software companies. But get rid of the fish tank first.

[EXE]

Darrel Ince is a Professor of Computing Science at the Open University. He will be sending a large sum of money, in used unmarked tenners, to the Editor of .EXE, in return for which we will not reveal his personal telephone number to the Aquarium Society of Great Britain [Telephonic Abuse division].

The Institute of Software Engineering can be found at 30, Island St, Belfast BT4 1DH. The manager in charge of software capability assessment is Ken Thompson - 0232 738507.

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CIRCLE NO. 068

Preserving Data with Ark

What's this? A spreadsheet-like thing in .EXE? Have the suits finally won? Indeed not - experienced programmers can develop substantial applications with the unusual Ark program, as Stephen Morris explains.

At first glance, Ark looks like an ordinary spreadsheet: titles around the border, columns of data, a strip of pull-down menus. Delve a bit deeper and you soon discover that, although Ark incorporates most of the features you would expect to find in a spreadsheet program, it is in fact something quite different. Ark, from Ambit Research, doesn't fit into any of the traditional categories of PC software.

Program Operation

The program starts with a front-end User Menu. This you set up yourself, including worksheets, program routines and further sub-menus (Figure 1). To edit a worksheet or run a routine, just select the relevant menu option and hit Enter.

There are no complicated loading and saving options - everything is automatic. Every time you move from one worksheet to another, escape to the User Menu or change program mode you are asked if you want to save your data. This happens frequently, so it is almost impossible to lose any significant amount of data - short of power failures, lightning strikes, magnetic media errors, crass stupidity...

Data Storage

The key to creating a successful application is in understanding how data is stored. Put aside any preconceived ideas about traditional database record structures; they have no place in this package.

As far as Ark is concerned it is the definition of the data, not its position, that is important. Each application - which can incorporate many dozens of worksheets - holds all its data in a single 'pot'. This is a DOS file, with no recognisable structure but with an identifying tag attached to each item of data.

This approach may seem rather chaotic but actually it works very well. Ark takes full responsibility for finding the data when it is needed. Losing control of the storage of

***Programming in
Ark is something
of a culture shock
for those more
used to
traditional
methods***

data in this way is unnerving at first, and the importance of making regular back-ups becomes paramount! Ark does help out by providing built-in back-up methods.

Ark works from the premise that a piece of data on its own is meaningless. Data is valuable only if you know what it represents and if it has a unique definition. The figure of 70553 on its own tells you nothing. It is only when a label of Sales/1989/Actual/North/Lawn-mowers is attached that it begins to have meaning.

In many respects this makes programming much easier. With a record-based file, a particular item of data is found by searching for a record according to the value of key fields, then calculating the position of the required field from the start of the record; this yields a record number and offset. When programming in Ark you stick with the wordy definition and let the program do the rest.

Ark maintains a dictionary in which are stored the descriptive names that you use. When the data is stored, the tag exists physically as a sequence of codes that identify names in the dictionary. Of course, the lack of file structure does create a considerable overhead - each data value needs a minimum of 30 bytes. An application of reasonable size will consume notable amounts of disk space.

However, there are some savings and these can be quite substantial. No space is wasted by setting up arrays in which many elements are never used; there is no need to allocate long record lengths to allow for maximum possible data size. In practice, spreadsheets generally require less disk space when transferred into Ark.

An added feature is that the tag includes the date and time when the data was created and the initials of the person who entered it. As you move around a worksheet, this information is shown at the bottom of the screen. So if you do change someone else's data, everyone will know who dunnit.

Data Definition

You must be able to give a unique name to every item of data. In each case, the first question you ask is: What does this data represent? The answer gives you the name of something you are measuring - the entity. It may be 'Sales', 'Quantity', 'Age', 'Opening Stock' or any other name. Each entity is further described by one or more attributes. You need enough attributes to uniquely define the data. For example, the attributes for Sales data may be Period, Analysis (Actual, Forecast etc), Region and Product. Thus '1989', 'Actual', 'North' and 'Lawn-mowers' are all examples of attributes and this particular group identifies one item of Sales data. Other Sales items are defined by changing the attributes.

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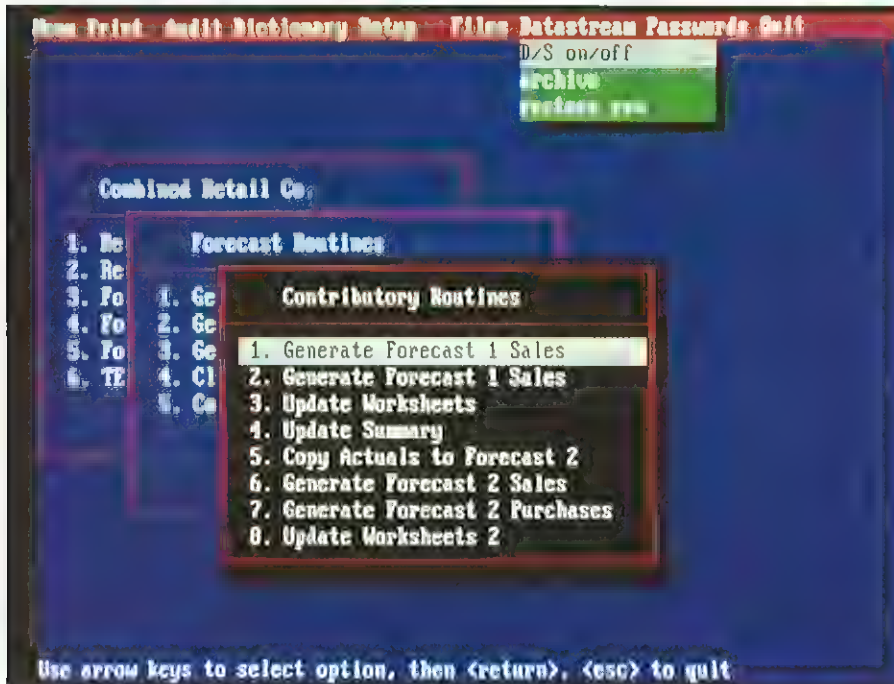


Figure 1 - An Ark User Menu

Analysis Business	Forecast 1 Northbury Electrical	This year	1989		
Retail Sales		Sales forecasts 1990 - 1993			
	1989	1990	1991	1992	1993
Sales					
1st Qtr					
Hardware	64,862	71,682	78,858	86,735	95,403
Materials	13,565	15,193	16,712	18,383	20,221
Fittings					
2nd Qtr					
Hardware	64,903	72,691	79,968	87,956	96,752
Materials	25,498	28,549	31,404	34,544	37,990
Fittings	12,234	13,702	15,072	16,579	18,217
3rd Qtr					
Hardware	39,845	44,626	49,689	53,998	59,398
Materials	30,554	34,221	37,643	41,487	45,548
Fittings	21,095	23,626	25,989	28,588	31,447

F1 - options05/06/90 9:51 WPC

Figure 2 - An Ark worksheet

Perhaps the best way to start is by thinking of the data as being stored in multidimensional arrays. Each entity name is analogous to an array name. The Sales entity name is equivalent to a four-dimensional array. If the application covers five years, three analyses, four companies and 80 products, a conventional array structure would require you to set aside enough space in memory for 4,800 values - and a similar amount on file. With Ark, you need set nothing aside; data is read from memory as and when it is needed.

Surprisingly, perhaps, the hard part is in deciding just what is an entity and what are its attributes. Once you start to analyse the data you will find that several possible structures spring to mind. It is not a disaster if you don't get it right first time - Ark has facilities for adding new attributes or taking away superfluous ones - but often you have no alternative but to throw it all away and start again. However, the second time around you can build your application in a fraction of the time.

This definition stage is all about understanding your data and knowing how it relates to the real world (a tricky concept for programmers at the best of times!). It can also require some interesting lateral thinking. It may seem that a Revenue item from a shop should be defined by the Sales Assistant, Shop and Town (amongst others) but, if each Sales Assistant is uniquely coded or named, the other two attributes are not necessary. A Shop can be defined as a collection of Sales Assistants and a Town as a group of Shops.

Creating Worksheets

Once the data definitions have been sorted out you can get down to the business of setting up the worksheets, on which data will be entered, interim calculations performed and reports generated.

Again, the approach is the reverse of more traditional methods. On a normal spreadsheet the data is positioned first and labels are added above and to the left, to serve as a reminder of the function of the data. For example you may have column headings for Opening Stock and Sales, with the 80 product names listed down the left-hand side. This will give you a sheet for a particular period, analysis and company. To cater for all five periods, three analyses and five companies you would need 60 copies of the spreadsheet file.

An Ark worksheet looks the same (Figure 2) but it is the position of the labels that determines the location of the data. The concepts - entity names, attributes and others - are placed on the worksheet first and define the meaning of individual data cells. When the concepts are complete and you start to enter data, Ark will only let you fill those cells that have a unique definition.

If you don't include any examples of a particular attribute on the worksheet, Ark creates a context window at the top of the screen. Here you fill in the missing values. By changing the context, you can view other data. For example, the worksheet for the North will have an identical structure to that for the South but with completely different data. To view a different set of data, all you need do is type a different Region name in the context window.

In this way, you need only one worksheet to cover all 60 possible variations, and you can pull out the data for any combination of context instantly.

You can now go on to create other worksheets, based on the same data. This is where Ark really comes into its own. Be-

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```
FILTER 1990_Actual_North
IF Sales > Target THEN
  INCLUDE Product IN Successful Products
```

Figure 3 - Filling a set

cause of its unique definition, each item of data need be entered only once. For instance, you can keep the product names down the left-hand side but put the Periods along the top. If the word 'Sales' appears in a suitable position on the worksheet, the new context window asks only for Analysis and Region. When you select values for the context, Ark extracts the data and displays it, giving you a whole new way of viewing the data.

Of course, you don't have to stick to one set of data. A single database can cover every aspect of an application, with worksheets containing hundreds or thousands of data items. Once the data is there, you can mix and match to your heart's content.

Tracing the Data

With a database of this size, awash with data, it would be easy to get lost and be overcome by the complexity of it all. This is where the principle of provenance comes in.

Ark remembers where each item of data was originally entered. On any worksheet the data is colour-coded: white for original data, yellow for data entered elsewhere. Move the cursor onto a 'yellow' item and press function key F7, and Ark loads and displays the worksheet where the data was originally entered, with the cursor on the correct cell. This is the provenance of the data.

You can move the cursor to another cell and repeat the process, travelling along a chain of worksheets. At any time, the backtrack key (F6) takes you back a step, until you eventually arrive back where you started.

Programming

So much for the worksheets. The real power of the system only becomes apparent when you start to use the built-in programming language. Programming in Ark is something of a culture shock for those more used to traditional methods.

Once you have sorted out the structure, the next immediate problem is: How do you do anything useful with the data? One answer is to use worksheet formulae. At their simplest these follow broadly the same rules as those of any other spreadsheet. Any cell values are changed with a MAKE statement. For example, to calculate the Total Sales,

enter a formula such as:

```
MAKE B85 = SUM(B4..B83)
```

You can have more complex formulae instructions, including a conditional IF...ELSE construct and a REPEAT

As far as Ark is concerned it is the definition of the data, not its position, that is important

statement that repeats one or more instructions for any collection of cells.

But suppose you want to test the effects of a 10% price rise by setting the 1992 Prices for Forecast 2 at 10% above those of Forecast 1? Although you could devise a worksheet to do the job, this is an ideal task for an Ark routine.

In most programming languages you would have an instruction in the form:

```
PRICES(3,2,1,j,k) =
  PRICES(3,1,1,j,k) * 1.1
```

This rather unpleasant instruction would be embedded in three nested loops. Ark provides a very neat solution:

```
FILTER Prices_1992
MAKE Forecast 2 =
  Forecast 1 * 110%
```

Within a routine, each MAKE statement acts on a class of data, rather than a single item. The FILTER statement tells Ark to select the class of data that matches the names that follow: ie anything with 'Prices' or '1992' in the tag.

The MAKE statement takes all Forecast 1 data (as restricted by the FILTER) and

adds 10%, putting the results in the corresponding Forecast 2 slots. This is repeated for all products and companies. With two instructions you have changed 320 pieces of data.

This is extremely effective but it does need some careful thought, otherwise you can end up changing data unintentionally. The results can be quite devastating; for example:

```
MAKE 1992 = ""
```

This single instruction zaps all the data for 1992 (across all entities). This is great for tidying up your database but not the sort of instruction you want to leave lying around in a routine.

There are some quirks of the system that take a while to get used to. The MAKE statement only acts in those cases where the data already exists on at least one side of the expression. If there are gaps in your Forecast 1 data, then there will be corresponding gaps in Forecast 2. Any existing Forecast 2 data for which there is no Forecast 1 will be deleted. This can be confusing but it is generally solved by good data management.

Sometimes a routine doesn't affect any data and tracking down the cause can be tricky, although Ark has reasonable single-stepping facilities. The answer may lie in generating some dummy data on a worksheet just so that the routine has something to work on!

If you don't restrict the scope of the MAKE statements with a suitable FILTER statement you may end up changing a lot more data than you bargained for. However, there are comprehensive audit facilities that let you list any class of data and find out where it came from.

Programming in Ark can be quite a taxing business and requires constant questioning: Which is the best way to handle this particular problem? Inevitably, there are at least two answers, including one that is very elegant and another that is horrendous! As with all programming tasks, there is a great deal of satisfaction when you come across the elegant solution.

When changing lots of data, routines provide the answer. For complex calculations, it is better to stick to worksheet formulae.

```
CATEGORISE Company IN All Credit Sets
BY Credit Rating + " Companies"
```

Figure 4 - CATEGORISE instruction

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You can merge the two in a routine with a DO statement:

```
DO Total Sales
```

This loads the Total Sales worksheet, executes all the formulae and saves away the changes, a far simpler approach than trying to incorporate the formulae themselves in routines. The DO statement is also used to run routines.

To get input from a user, the routine can include a statement such as:

```
INPUT Total Sales
```

This time the worksheet is loaded and the user can make changes to the data (or even the layout). When the user escapes out, the changes are saved and the next instruction in the routine is executed.

In this way, you can set up a worksheet to get any input you like from the user. However, some worksheets may appear somewhat contrived and all are very much in the Ark style. That said, you can create a whole string of bug-free input screens in a matter of minutes.

Sets

As a spreadsheet-type product, Ark is fun to use and in most respects matches all other offerings on the market. But to create powerful applications you need a couple of other features.

The first of these is the set, which is a group of attribute names. For example, the Period attribute may have a set called 'All Years' that comprises 1989, 1990, 1991 etc. Another set, 'All Products', may list the 80 product names. These sets can be used in both worksheets and routines.

To create a worksheet comparing Sales values on a year-by-year basis requires only three concepts: Sales and All Products on the left, All Years at the top. When you change to Data Entry mode (there are several operating modes), Ark does the rest for you. The sets are expanded to show all the names around the edge and the corresponding grid of data is displayed.

Sets can be filled out manually (using the pull-down menus), within a worksheet (by listing them below a set name) or from within a routine (see Figure 3).

As before, these instructions are carried out for all matching data. In this case there are two entities: Sales and Target, defined by the Period, Analysis, Region and Product. For all 1990 Actual data, Ark compares the Sales value with the corresponding Target

```
WITH This Company = All Companies DO
DO Create Second Forecast
```

Figure 5 - Representatives in routines

and, if it is greater, adds the product name to the set of Successful Products. Now all you need to do is type the name 'Successful Products' on a worksheet and Ark will display the required list.

***Once you have
grasped the
principles, you
can create
complex data
structures
literally in seconds***

If every Company has a Credit Rating (Good, Bad etc), you can create sets such as Good Companies and Bad Companies, where each set contains only the relevant customers. This is achieved with a single CATEGORISE instruction (Figure 4). As an added bonus, you get a set called All Credit Sets that contains a list of the new sets.

Variables

As a programming language, Ark is very unusual in having no variables! There is something similar, though, called a representative. This does what it says - it represents an attribute. For example, This Year may be a representative of Period.

If there is a representative on a worksheet, the user is asked to fill in its value. The corresponding data is loaded. Here, as in many other places within Ark, all you need do is press F5 to select from a pop-up list.

One representative can be derived from another. For instance, the definition of Last Year may be:

```
All Years, This Year - 1
```

If This Year currently has the value '1990', Ark searches the All Years set for 1990 and then puts the previous member of the set in Last Year: 1989, assuming you have ordered the set members correctly.

Put both of these representatives at the top of the worksheet and you need only select one year (This Year) to generate two columns of data.

Representatives are useful in routines. In Figure 5, the routine 'Create Second Forecast' is executed a number of times, each time with the representative (This Company) taking a different value from the set All Companies.

To extend this system further, there are representative sets. These are variables that stand for set names. If there is a representative called New Town, derived from All Towns, then a representative set called New Town's Customers can be derived as:

```
by name, New Town + "Customers"
```

When you enter the name of a New Town (eg 'Hereford'), a Town attribute called Hereford is created and added to the set of All Towns. At the same time the set Hereford Customers is created and can be filled out on a worksheet or within a routine.

This is fairly complex stuff, and takes a lot of getting used to. However, once you have grasped the principles, you can create complex data structures literally in seconds.

Conclusion

Ark is extremely powerful, yet the underlying idea is remarkably simple. You won't master the programming language overnight but, once you have done so, application development time is reduced dramatically. From the end user's point of view the operation of any Ark application is straightforward and requires little training.

Adapting to Ark's way of doing things takes time, especially for a seasoned programmer, but there is no doubt that Ark is going to change the way we all look at and use our data.

EXE

Stephen Morris is a freelance technical author and has written a number of books describing PCs and PC software. He is also the author of the Ark user manuals. Ark is produced by Ambit Research Ltd, with a starting price of £1950. Ark is available direct from Ambit Research (071 731 8199).

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Helping Hands

*The Microsoft Windows help system is powerful and slick.
But, as Jeffrey Goldberg discovered, it's not that easy to use in applications.*

In a review of the Windows 3 SDK (*EXE Magazine*, November 1990), I mentioned that Microsoft had provided the tools to allow a sophisticated help system to be added to a Windows 3 program. The tools to create this help system are also now bundled with Borland and Zortech compilers. This article describes how this help system works from a programmer's and help writer's viewpoint.

You might ask: given that the *Programming Tools Manual* of the Windows SDK provides an explanation of the help system, why would someone write an article such as this? Quite simply, the code provided in the manual has a myriad of problems, and the explanations provided are shrouded in Microsoftese. Indeed, the help system looks a last minute addition to the SDK, further confirmed by Microsoft using an

older version of the help system for Windows Word 1.1 and Windows Project.

The Windows Help System

The Windows help system provides all the attributes of a good help system and with the important benefit of being a Windows program. It is essential that you know how the Windows help system looks from a user's perspective before delving into the gory details, otherwise you'll get lost; so let's take a closer look.

The context sensitive entrance to the help system is by pressing F1 at a convenient point, for example a menu or in the main window of the application. Unfortunately, this won't give help on subsidiary parts of the application such as the window border or child windows that need to be picked

using a mouse. Windows therefore provides the Shift-F1 help mode, which turns the mouse pointer into a combination of a pointer and a question mark, allowing you to move to the feature and press the mouse button to obtain help.

Context sensitivity isn't the only way into the help system. A Windows program should have a help menu as the last item on the menu bar. This allows someone to select the main index, a list of the keyboard short-cuts or procedures, or help on how to use the help system. Although we won't cover Computer Based Tutorials (CBT) in this article because they can't easily be made with the help system, the help menu should contain an entrance to a CBT if one exists. It is inevitable, however, that the Windows help system will move towards a full CBT authoring system in the future.

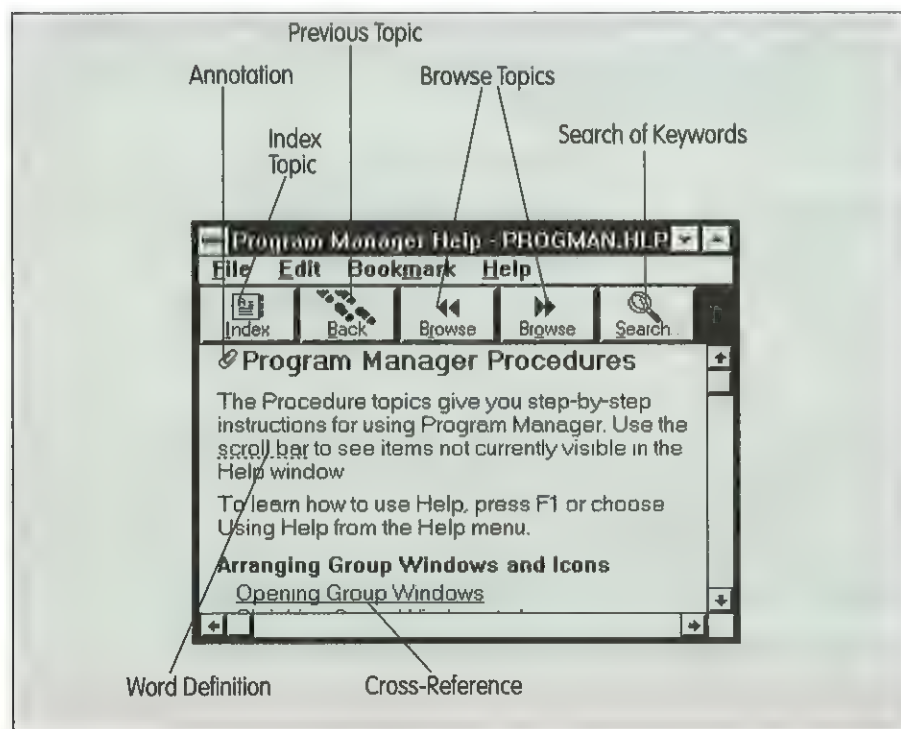


Figure 1 - Screen Dump

As you can see in Figure 1, once in the help system you have many possibilities. A typical topic has normal text interspersed with two special types of words: Cross-References and Word Definitions that you mouse-click on or press Enter, to reveal their contents. A Cross-Reference is a jump to another topic allowing you to find a related topic quickly. For example a Search help topic should have a cross reference to a Replace topic. You are not returned to the previous topic automatically; instead you need to click the Back button. The Word Definition opens up a small window allowing an explanation of a word like an electronic glossary, though you can also use it for a helpful hint on a particular function. When you let go of the button or Enter key, the window closes so you go back to the original topic, at the expense of naïve users who do not know how to keep the definition window open.

The icons at the top of the window make the help system look pretty, while also serving a useful purpose. They allow the user to go to the main index of help topics, to

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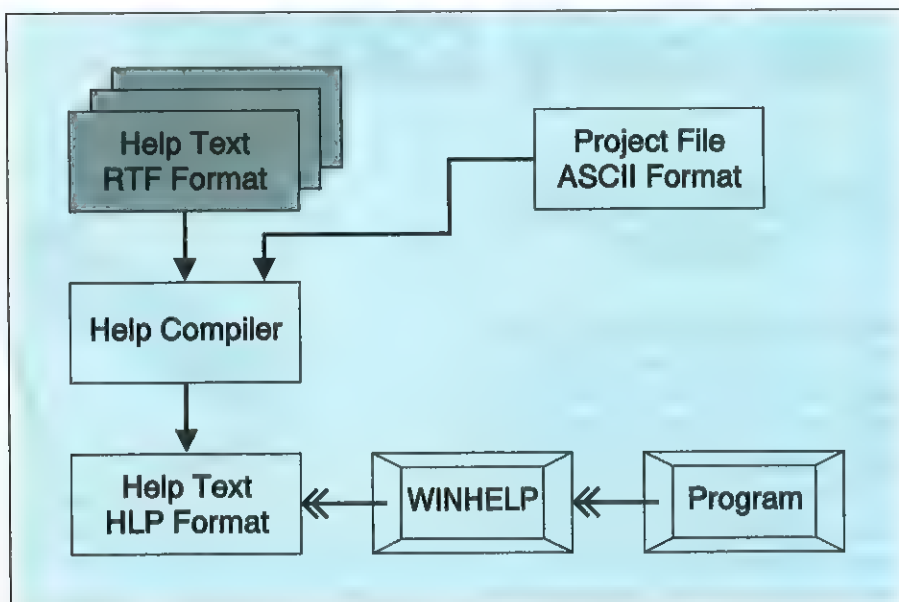


Figure 2 - The Help Compiler.

Value	Meaning and dwData value
HELP_CONTEXT	Shows help for a topic identified by the unsigned integer dwData.
HELP_HELPPONHELP	Shows Using Help index topic.
HELP_INDEX	Shows main Help index topic.
HELP_KEY	Shows help for a topic identified by keyword given by the long pointer to a string dwData.
HELP_QUIT	Closes help for your application

Two other settings of wCommand, HELP_SETINDEX and HELP_MULTIKEY, are for when you want more than one index in your help text - a rare occurrence and not covered in this article.

Figure 3 - wCommand values

several previous topics, to browse through related topics and to search for a particular topic. The search isn't a string search, a feature that Microsoft omitted from the help system, but an index search that pops up a dialog box. You type in the Search box or use the list box below to select a Keyword, in the same way that you might search a

book index for a particular entry. Once you press the Search button, the help system searches for help topics with that keyword; the ones it finds it puts in the list box at the bottom of the dialog box. The list box contains the titles of the topics related to the index, just like a selection of page numbers related to a single topic in a book index. You then press the Go To button to view the help topic. This is unwieldy, since most help system writers use a one-level system with the same keyword in the index as the title in the topic.

The help system also comes with a series of menus to allow you to copy and print a topic, add an annotation and a bookmark to the help topic. The help system only allows you to copy a complete topic so if users are likely to copy a topic frequently (eg a language reference) you need to structure the help text accordingly. The annotation allows someone to add a note to a particular topic - it is entirely user driven with nothing required from help writer or programmer. A bookmark, on the other hand, is different because while the user drops the bookmark, the default title in the resulting dialog box comes from the help topic.

From the user's point of view, the help system is reasonably friendly. Let's see if this is true from the programmer's point of view. The help system consists of additions to the code to support the help system, context sensitivity and the help menu; the help text made with a Rich Text Format (RTF) compatible word processor; and the help compiler's project file. As shown in Figure 2, you feed the help text and the project file into a woefully slow help compiler that generates a compressed .HLP file. The program then uses the Windows API to activate the help application to do the look-up and display of the help topic.

Application Code

The help system has just one innocuous looking API call:

```

BOOL WinHelp (hWnd,
               lpHelpFile, wCommand,
               dwData)

```

hWnd is a handle to the calling window, allowing the help application to keep track of the applications that request help. The lpHelpFile is the path name of the help file containing the help topic. The wCommand tells the help application the function you want - see Figure 3.

It looks so easy - all you need to do is put calls to WinHelp at appropriate places and let the help writers do their stuff. After you have read the article and perused the source code, it *will* seem that easy, so long as you ignore the Microsoft Programming Tools manual and sample source code.

The first thing you'll need do is to add code that initialises and destroys the help system. Initialising consists of finding where your help file hangs out and constructing a fully qualified pathname for the lpHelpFile parameter of WinHelp. I suggest that you assume that by default the help file is in the

```

case IDM_HELP_INDEX:
    WinHelp(hWnd, szHelpFileName,
            HELP_INDEX, 0L);
    break;

case IDM_HELP_KEYBOARD:
    WinHelp(hWnd, szHelpFileName,
            HELP_KEY,
            (DWORD) (LPSTR) "keys");
    break;

case IDM_HELP_COMMANDS:
    WinHelp(hWnd, szHelpFileName,
            HELP_KEY,
            (DWORD) (LPSTR) "commands");
    break;

case IDM_HELP_PROCEDURES:
    WinHelp(hWnd, szHelpFileName,
            HELP_KEY,
            (DWORD) (LPSTR) "procedures");
    break;

case IDM_USING_HELP:
    WinHelp(hWnd, szHelpFileName,
            HELP_HELPPONHELP, 0L);
    break;

```

Figure 4 - Help menu code

```

/* Somewhere in initialisation code */
hMenu = GetMenu(hWnd);
ahPopupMenuID[0] = GetSystemMenu(hWnd, 0);
for (i=1; i < GetMenuItemCount(hMenu)+1; ++i)
    ahPopupMenuID[i] = GetSubMenu(hMenu, i);

/* In the window procedure */
case WM_MENUSELECT:
    bInMenuBar = (BOOL) (lParam & MF_POPUP);
    wCurrentMenuID = wParam;
    break;

case WM_ENTERIDLE:
    if ((wParam == MSGF_MENU) &&
        (GetKeyState(VK_F1) & 0x8000) &&
        !bShiftF1Mode)
        PostMessage(hWnd, WM_HELP,
                    wCurrentMenuID, 0L);
    break;

```

Figure 5 - F1 within menus

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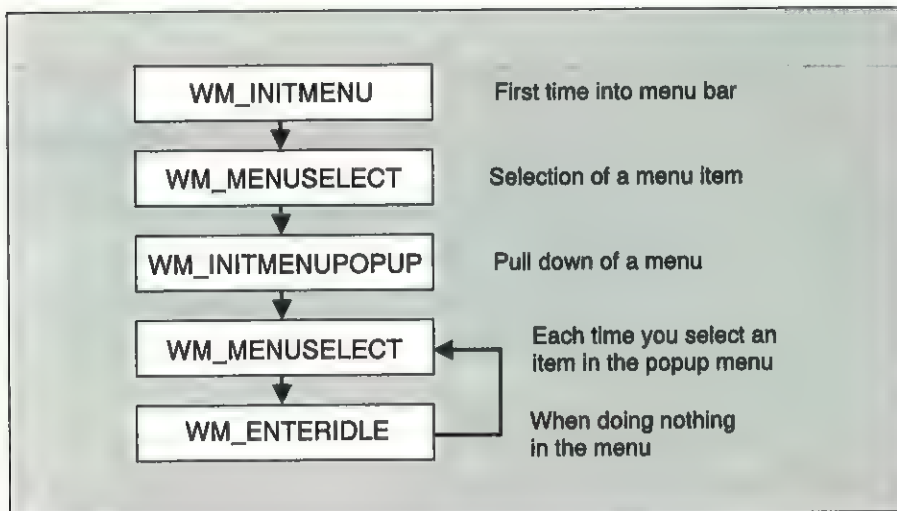


Figure 6 - Menu Messages.

same directory as the executable. You can then find out the path name of the executable with `GetModuleFileName`, remove the filename from the path and substitute the .HLP filename. The help application initialises itself when you first call, but you do need to call `WinHelp` when you're through. To do this you should put a call to `WinHelp`, with a `wCommand` of

```

case WM_HELP:
    switch (wParam) {

        /* Non-client area item */
        case HTTOPRIGHT:
            dwHelpContextId =
                (DWORD) HELPID_SIZING_BORDER;
            break;

        /* System menu item */
        case SC_MAXIMIZE:
            dwHelpContextId =
                (DWORD) HELPID_MAXIMIZE;
            break;

        /* Pull down menu */
        case IDM_NEW:
            dwHelpContextId =
                (DWORD) HELPID_FILE_NEW;
            break;
        default:
            dwHelpContextId = (DWORD) 0L;
    }

    /* Menu Items */
    if (bInMenuBar) {
        dwHelpContextId =
            (wParam == ahPopUpMenuID[0]) ?
                (DWORD) HELPID_SYSTEM_MENU :
            (wParam == ahPopUpMenuID[1]) ?
                (DWORD) HELPID_FILE_MENU :
            (wParam == ahPopUpMenuID[2]) ?
                (DWORD) HELPID_EDIT_MENU :
            (wParam == ahPopUpMenuID[3]) ?
                (DWORD) HELPID_HELP_MENU :
            dwHelpContextId;
    }

    if (!dwHelpContextId) {
        MessageBox(hWnd,
            "Help not available for item",
            "Help Example",
            MB_OK|MB_ICONINFORMATION);
        return (DefWindowProc(hWnd, message,
            wParam, lParam));
    }

    WinHelp(hWnd, szHelpFileName,
        HELP_CONTEXT, dwHelpContextId);
    break;
  
```

Figure 7 - WM_HELP handler

`WM_QUIT` in your `WM_DESTROY` message handling.

The help menu is the next easiest part. In my worked example, I added a Help menu with a pull-down consisting of Index, Keyboard, Commands, Procedures, Using Help and an About entry leading to a dialog box. The code to handle the menu is within the `WM_COMMAND` handler (Figure 4).

The help text needs to have topics with the keywords keys, commands and procedures defined, otherwise an error will result when someone uses the menu items. You should also add the appropriate menu to the resource file. It is similarly trivial to make pressing F1 within the client area of the application generate help, simply by checking for F1 in the `WM_KEYDOWN` message.

Things start to get tricky if you want someone to be able to press F1 in menus to get help. Windows doesn't provide any hooks for the help system in the menu handler. This means that you have no way of determining the menu id of the selection without adding code to handle the `WM_MENUSELECT` and `WM_ENTERIDLE` messages - please see Figure 5. The first code fragment goes somewhere in your initialisation code, eg `WinMain` or `WM_CREATE`. It gets the handle of the menu bar and then fills an array with the menu ids of the system menu and items in the menu bar. `GetMenuItemCount` gives the number of items in the menu bar and `GetSubMenu` the handle associated with the menu given by position `i`.

The `WM_MENUSELECT` handler gets called for each menu item, so to avoid slowing down menu handling it should do the minimum amount of work. Indeed, all

it does is to set a Boolean indicating whether the selection is a pop-up menu and record the current menu ID or pop-up menu handle for later analysis. The `WM_ENTERIDLE` message is produced when Windows detects that you are in a menu or dialog box but doing nothing (see Figure 6). It is safe to do more lengthy here, so this is where we check if someone is in a menu, having pressed F1, and open the appropriate help topic using `PostMessage`. You might think that posting an application defined message `WM_HELP` is wasteful compared to a direct call to `WinHelp`, but it makes for more modular code and allows you to support F1 in dialog boxes.

`WM_HELP` (Figure 7) consists of a very inefficient translation between menu or other ID and help ID; checking a Help ID exists; and then calling `WinHelp` with the right context. You are helped with this translation by the `#defines` beginning with `HT` (for Hit Test) starting at 0, and the `SC` (for System Command) starting at `0xF000`, so you can place your `IDM` `#defines` anywhere between 100 and `0xEFFF`. You don't have any control over the value of the pull down menu handles, so the check of the array of menu items is only done when in the menu bar.

You now have F1 support in menus and the client area but not in dialog boxes. The

```

int FAR PASCAL HelpKeyFilter
    (nCode, wParam, lParam)

int         nCode;
WORD        wParam;
DWORD       lParam;
{
    LPMSG Msg;
    Msg = (LPMSG) lParam;
    if (nCode == MSGF_DIALOGBOX) {
        if (Msg->message == WM_KEYDOWN &&
            (Msg->wParam == VK_F1))
            PostMessage(hWnd, WM_HELP,
                IDM_PASTE, 0L);
    }
    return (DefHookProc(nCode, wParam,
        lParam, lpfnOldHook));
}

// Installation and deletion of filter

case WM_CREATE:
    lpfnHelpKeyFilter =
        MakeProcInstance(HelpKeyFilter,
            hInst);
    lpfnOldHook =
        SetWindowsHook(WH_MSGFILTER,
            lpfnHelpKeyFilter);
    break;

case WM_DESTROY:
    UnhookWindowsHook(WH_MSGFILTER,
        lpfnHelpKeyFilter);
    FreeProcInstance(lpfnHelpKeyFilter);
    WinHelp(hWnd, szHelpFileName,
        HELP_QUIT, 0L);
    PostQuitMessage(0);
    break;
  
```

Figure 8 - F1 dialog box filter

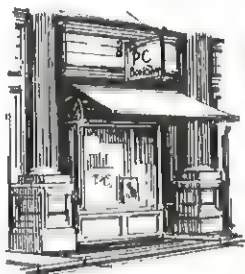
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```

case WM_COMMAND:
    if (bShiftF1Mode) {
        bShiftF1Mode = FALSE;
        PostMessage(hWnd, WM_HELP,
            wParam, 0L);
        return (DefWindowProc(hWnd, message,
            wParam, lParam));
    }
    break;

case WM_KEYDOWN:
    if (wParam == VK_F1) {
        if (GetKeyState(VK_SHIFT)) {
            bShiftF1Mode = TRUE;
            SetCursor(hHelpCursor);
            return
                DefWindowProc(hWnd, message,
                    wParam, lParam);
        }
        else {
            WinHelp(hWnd, szHelpFileName,
                HELP_INDEX, 0L);
        }
    }
    else if (wParam ==
        (VK_ESCAPE && bShiftF1Mode)) {
        bShiftF1Mode = FALSE;
        SetCursor((HCURSOR)GetClassWord(
            hWnd, GCW_HCURSOR));
    }
    break;

case WM_NCLBUTTONDOWN:
    if (bShiftF1Mode &&
        (wParam != HTMENU)) {
        bShiftF1Mode = FALSE;
        PostMessage(hWnd, WM_HELP,
            wParam, 0L);
    }
    return (DefWindowProc(hWnd, message,
        wParam, lParam));
    break;

case WM_SETCURSOR:
    if (bShiftF1Mode)
        SetCursor(hHelpCursor);
    else
        return
            (DefWindowProc(hWnd, message,
                wParam, lParam));
    break;

```

Figure 9 - Shift-F1
dialog support

easiest way is to add a button labelled Help and post an appropriate WM_HELP message. This doesn't allow someone to press F1 and get help, although you can use the short-cut Alt-H. If you really want the ability to press F1 in a dialog box then you need

to get into the arcane world of a Windows hook.

Windows provides several hooks to allow an application, or more usually a DLL, to process an event before it gets to an application's message queue. The hook we'll use is WH_MSGFILTER, which calls an application nominated procedure whenever a dialog box, message box or menu has retrieved the message but before it has processed that message. We thus need to filter out the F1 key in a dialog box and post the appropriate WM_HELP message. To install and delete the filter you need to add code to, for example, the WM_CREATE and WM_DESTROY messages (Figure 8).

Shift-F1 support is straightforward compared to supporting F1, for example you can add the code in Figure 9 to your window procedure. The key to Shift-F1 support is the handling of WM_KEYDOWN, which detects Shift-F1 and allows you to escape from the mode. Once in the mode, WM_SETCURSOR makes sure you keep the help cursor when the mouse pointer has made an excursion outside the window. Context detection in Shift-F1 mode uses the WM_NCLBUTTONDOWN message for non-client areas such as the title bar, but for menus we use WM_COMMAND. The latter has the unfortunate side effects such as you can't get help on greyed items, top level menus or on items within the system menu. This isn't a problem, however, as you can get help on these using F1.

The Help Text

I have now shown how to write the code. What about the help text? The help text is a document made into an RTF file with commands as footnotes, underlined, double underlined and hidden text. You can use

most word processing attributes in your file including different fonts and font attributes, tabs and paragraph borders. The table in Figure 10 gives a summary of what you can and cannot do.

The centre of the commands is the context string, defined by adding a footnote reference of # and a footnote text of, for example, # HELP_ID_FILE_EXIT. If you want to make a cross-reference or definition to that topic then you use HELP_ID_FILE_EXIT to tell the help compiler the destination. Similarly, in your code when you call WinHelp with HELP_CONTEXT, it is HELP_ID_FILE_EXIT that you use for dwData.

Most help systems allow browsing from one page to another without a help writer's knowledge. However, this isn't what the Windows help system does. Instead, the help writer must specify the topic that precedes and follows the current topic. To specify the sequence you add a footnote reference of + and footnote text of the sequence type and number. For example the file menu could consist of a footnote text of: FileMenu:005, FileMenu:010 and FileMenu:015 and the edit menu: EditMenu:005 etc. If you are on FileMenu:010 then you can go back to FileMenu:005 and forward to FileMenu:015, but not to any EditMenu item. A trap for the unwary is that the help compiler has an ASCII sorting sequence so '15' comes *after* '100', hence the leading zero(s).

Finally, you can incorporate a bitmap into the help text in a number of ways. The simplest is using a Windows word processor to paste the bitmap from the clipboard. However, that becomes wasteful and requires re-pasting when the bitmap changes. The help compiler provides three commands to pull in bitmaps, similar to Field Codes in *Word for Windows*. You enter these commands into the text using curly brackets, for example {bmc ARROW.BMP} treats the bitmap as a character. If you do this, then you can use a bitmap as a cross-reference or definition, allowing the possibility of interesting effects without increasing the size of the help file.

Pulling it together

The connection between the help text, C code and output is the HPJ project file - an ASCII file containing directives like WIN.INI. Figure 11 contains an example.

The FILES section lists the RTF files used to make the help system. The BITMAPS section lists the bitmaps used with the curly

DOs	DON'Ts
Fonts: Tms Rmn, Helv, Courier, Modern, Roman	Fonts: Script and Symbol
Attributes: Font size, Bold, Italic, Underlines	Attributes: Word underline, double underline, superscript, subscript, small caps and strikethrough
Paragraphs (Enter in WinWord)	New Lines (Shift-Enter in WinWord)
Borders and boxes in all attributes	Shaded, absolutely positioned and Side-by-Side paragraphs
Tabs including left, right, centre and decimal	Tables
Paragraph indents and spacing	Right Margin determined by window size
Monochrome and Colour bitmaps	Only monochrome BMP format recommended as colour BMP might not work properly on monochrome screens.
Style Sheets	Footnotes and Field codes
Page Break = Topic End	Document formatting

Figure 10 - DOs and DON'Ts in help text


```
[FILES]
helpex.rtf ; main topics

[BITMAPS]
bullet.bmp

[MAP]
#include <helpids.h>

[OPTIONS]
INDEX=main_index
TITLE=Help Example
COMPRESS=false
ROOT=D:\HELP
```

Figure 11 - Project File

bracket bitmap commands, allowing the compiler to save space by avoiding duplicate copies of the bitmaps. These sections also allow you to produce a make file dependent only on the HPJ file, rather than a mess of bitmap and RTF files, because the FILES and BITMAPS sections list all of the files used in the help system.

```
#define HELPID_EDIT_CLEAR 100
#define HELPID_FILE_EXIT 200
#define HELPID_EDIT_WINDOW 300
```

Figure 12 - MAP header

The MAP section is the connection between the code and the help text. It defines the context numbers associated with the help context names - see Figure 12. You include this header file in both the C code and the HPJ file, while the help text contains the context strings such as HELPID_FILE_EXIT. This means that each time you add a new context in the program such as a 'File Save all' menu item, you need to add:

1. A #define, such as #define HELPID_FILE_SAVE_ALL 201 in HELPIDS.H.
2. An addition to WM_HELP to translate IDM_SAVE_ALL to the context HELPID_FILE_SAVE_ALL.
3. An addition to the help text containing a context string of HELPID_FILE_SAVE_ALL and some relevant information on 'File Save all'.

The OPTIONS section allows you to tailor the help compiler in many ways, but the example lists only the important options. INDEX specifies the help topic shown when someone presses the Index button in

the help application. If you don't specify the INDEX option then the compiler assumes, usually incorrectly, that the index is the first topic encountered. TITLE is the heading given to the help in the title bar of the application. Beware that the title has the word 'Help' automatically appended to the text. The COMPRESS option toggles compression of the help file. Keep this OFF until you are ready to produce a real version both to speed up the tortoise-like compilation and to allow compression to occur. The reason for the latter is that the help compiler makes a .PH file of repeated phrases but only rebuilds it when none exist. Finally, ROOT allows you to specify the directory for bitmaps and RTF files.

EXE

Jeffrey Goldberg likes bungy jumping and is looking for something as exciting in the computer field. Contact him on CIX as Cricket or on 081 455 0801.

Jeff has supplied oodles of example code for this article which we do not have the space to print. However, it is available on disk for free (please see page 1 for details). Please mark your envelopes 'WHELP'.

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Introduction

Even in the sixties, Ted Nelson was working with the ideas which have now come to be called Hypermedia. After reading his now big Press ← to continue

Hypermedia has been talked about for decades, but somehow has never realised its potential. At last the technology we need is in place; now we are poised to start solving the real problems. Here is a hyperlinked document exploring those problems.

One of the leading organisations for research into Human Factors is SIGCHI, a branch of the ACM. SIGCHI organises conferences every year, dealing with all aspects of investigation into the human Press ← to continue

Now that Intel's DVI chips are coming online, and a standard is finally merging for the format of CD ROMs, it would appear that real hypermedia systems are to become a reality at last. Brand new satellites are going up for the express purpose of carrying data in this form, and the global village beckons.

This illustrates the real issue with hypermedia; it is not the technology which is important, nor is it the interaction between the technology and the user; the important issue is the information that is encoded into the technology, and it seems nobody is addressing this.

In Shakespeares *"Tempest"*, Miranda is so impressed by the sight of the shipwrecked sailors, (the first men she has ever seen, apart from her father) she exclaims "Oh, brave, new world, which has such people in't!". The story operates on several levels; Miranda has an idyllic environment, but the invasion of that environment, and her own natural instincts, conspire to sour it for the rest of the Press ← to continue

Oh, brave new world, which has such machines in't!

It seems every conference about user-interfaces these days is responding to this technology; people write about how to build casual-use systems for exhibitions, intensive-use systems for research, and even automatic correlation of data inside such systems. Some real projects have been undertaken, most with some degree of success. We have the hardware, we have the software, what more could we want?

Aldous Huxley, an incisive and insightful author, treated the role of the individual under repressive governments in a number of works. In later life, he became interested in the benefits of hallucinogenic drugs, particularly in their use in 'non-linearising' perception. In his book, *"Doors of perception"*, Press ← to continue

I remember reading a science fiction story some time ago, (which had all the subtlety of plot and character development for which the genre is famous!) which concerned a society in which all the books were written by machine in order to be ideologically sound (an idea stolen, no doubt, from *"1984"*). The people revolted, destroyed the machines, and sat down to write real books of their own. They couldn't - their society was so idyllic they had nothing to write about.

Science Fiction, that branch of literature dealing with future situations, has existed in a recognisable form since Jules Verne. Originally concerning itself with technical achievements, as it matured as a form it became more concerned with social criticism, with the technology acting more as a backdrop to enable situations to develop from the Press ← to continue

George Orwell was a committed socialist in his youth, but later turned his back on his previous beliefs, and wrote a number of books exploring the faults which he had previously been unable to see. His most famous work, *"1984"*, approached the position of great Press ← to continue

Biography

Jules May spent five years producing and directing animations, mainly for advertising. He has applied advertising techniques to disciplines as diverse as philosophy and embryology. He can be contacted on 0707 44185, or on CIX as Jules.

It's hard enough to write a book. People who understand their subject clearly enough to be authoritative usually are not very good communicators - and it is very rare for someone who understands communications also to understand a subject well enough to explain it fully. As examples, I'm sure most people have struggled through glutinous textbooks and learned almost nothing, while magazine articles have given a totally clear, but utterly inaccurate picture of the same subject.

Now it is claimed that by allowing an author to structure his material in forms other than linear we can expect his knowledge will be easier to assimilate. It's not that easy - first, the author must be able to find an appropriate structure (no mean feat in itself!), and then coerce his knowledge into his chosen form, which will be almost impossible if (as is often the case with experts) his knowledge is not highly structured in the first place.

These problems are going to be exacerbated, because the way in which hypermedia is commonly envisioned to work will push it towards the television-style "three-minute culture", leaping from one concept to another at the drop of a cognition.

Max Headroom alluded incidentally to the technology and drugs now known as cyberpunk. It described a synthetic TV show which has evol-

Press ← to continue

To be practical on a grand scale, hypermedia products will need to be created by more than just one author explaining his view of the world. Probably there will need to be a programmer close by, and also one other person - the communications specialist. This will be the person who understands what the author wants to convey, and designs the structure and language of the document to explain this most clearly.

I remember struggling for four years trying to understand calculus, until a communications researcher (who claimed to be a lousy mathematician, by the way) explained it all to me in four hours. There are very few people like that researcher, because the role is a new one.

Here are exactly the skills we are looking for. Here are the people who should be building hypermedia systems, but, believe me, they are not going to do it on programmers' salaries.

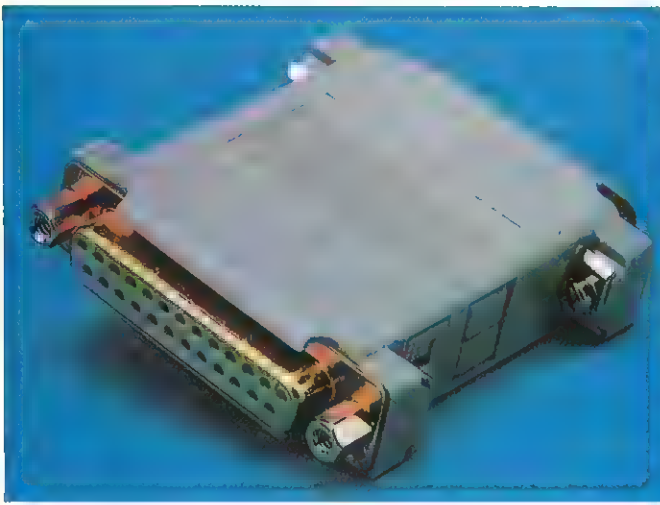
Advertisers are people who can take a revolutionary product (or an utterly boring one), and in thirty seconds, one hundred words, one picture, or whatever, identify exactly why the product is wonderful beyond dreams. To do this every word, every frame of film, contributes to the message, and by using languages which operate simultaneously on logical, emotional, and subconscious levels, they can cram more information into their allotted space than many authors do in full-length books. They are able to identify isolated, clean ideas and stick to their point throughout their message, and they are so good at this that they can do it when legislation prevents them from saying anything about the product (as in the case of cigarette adverts), or even (as with condoms and tampons) what the product is!

David Ogilvy, one of the most famous advertisers (see "From those nice guys who brought you Pearl Harbor"), regards his subject

Press ← to continue

There are some people at the Open University performing this function, but even the OU is not yet ready for hypermedia, because they insist on calling their specialists "graphic designers" and "scriptwriters", completely missing the point of what these people are doing. Some

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A load of old COBOL

*COBOL is hardly an obscure language, although some say it should be.
Christina Wheeler finds some strengths among its weaknesses.*

The first version of COBOL was produced by the Conference on Data Systems Languages (CODASYL) in 1959. The requirements of the design were that it should be easy to understand and document, easy to convert from one machine to another, and capable of being compiled into efficient object code for data processing problems.

The American National Standard Institute approved a standard version in 1968. However, the standard was not really adopted until it was updated in 1974. Most COBOL in use today is based on the 1974 standard, ANS COBOL 74, although most manufacturers also add their own extensions.

Another version, ANS COBOL 85, was released to provide better facilities in the language for structured programming. This included a 'case' statement (EVALUATE) and an ENDIF. Unfortunately, this version is still rarely used.

The language

COBOL was originally designed to look like English, in order that business people could write their own programs without recourse to computer professionals. No comment. Its basic building block is a word; either a reserved word (such as READ, ADD, PERFORM etc) or a user-defined word, which can have up to 30 characters. Admittedly, very few

programmers would use all thirty! Even so, the language seems very long winded when you come to it from another language.

Figure 1 gives an idea of the structure of a COBOL program. Each DIVISION consists of SECTIONS. These have fixed names for the first three, and user-defined names for the PROCEDURE DIVISION. SECTIONS may be further divided into PARAGRAPHS. Each of these is made up of a series of sentences, composed of clauses. This terminology clearly reflects the attempt to make the language English-like.

For all its faults, COBOL does have some strengths, notably the ability to describe business data. This is, of course, what it was designed for in the first place. What amazes me is that it continues to be used for applications for which it is not really suitable, and therefore ends up being unnecessarily maligned. Which brings us to the Triangle Problem. For such a small program, COBOL is indeed top heavy, as you still need to include all four divisions. Figure 2 shows my solution to the problem.

The IDENTIFICATION DIVISION

This identifies the program! As well as the name of the program, other information may be included, such as author's name, the name of the installation and so on. A comment about the function of the pro-

gram as a whole is usually included here.

The ENVIRONMENT DIVISION

The CONFIGURATION SECTION gives the types of computer on which the program is to be compiled and run. Portability was another of COBOL's original design considerations. Maybe my cynicism in this area is ill-founded, because I actually ran this program on a PC.

If the program were handling files, there would also be an INPUT-OUTPUT SECTION in the ENVIRONMENT DIVISION, connecting the program's internal file names to those used by the operating system.

The DATA DIVISION

The layout, as perceived by the program, of any such files would be described by the FILE SECTION of the DATA DIVISION. Each file is described with its format and the layout of however many types of record are required. COBOL is best suited to batch file processing and additional software may be brought into play for on-line processing or handling databases.

Working areas are described in the WORKING-STORAGE SECTION. The descriptions for WORKING-STORAGE and FILES are much the same. Elements can be grouped into logical chunks and a hierarchy described using level numbers. Thus,

<p>IDENTIFICATION DIVISION.</p> <p>I think I'll bake a cake!</p> <p>ENVIRONMENT DIVISION.</p> <p>I'll make it in the kitchen. We'll eat it in the sitting-room.</p> <p>DATA DIVISION.</p> <p>FILE SECTION.</p> <p>I'll need Eggs, Flour, Butter, Sugar, Milk, Fruit and Spices to go in it. When it's done, we'll have fruit cake for tea.</p> <p>WORKING-STORAGE SECTION.</p> <p>I'll need a bowl to mix it in, and a wooden spoon to mix it with. I'll need a tin to bake it in and a hot oven to bake it. I'll need a rack to cool it on and a plate to serve it on.</p>	<p>PROCEDURE DIVISION.</p> <p>MIX SECTION.</p> <p>Get the eggs, butter and milk from the fridge. Get the flour, sugar and spices from the cupboard. Put them in the bowl and mix them with the wooden spoon.</p> <p>BAKE SECTION.</p> <p>Transfer the mixture to the tin. Put it in the hot oven. Leave it there until it is cooked.</p> <p>COOL SECTION.</p> <p>Remove the tin from the oven. Remove the cake from the tin, and put it on the rack to cool.</p> <p>TEA SECTION.</p> <p>When it is cool, put it on the plate and take it to the sitting-room for tea.</p>
---	---

Figure 1 - A light-hearted look at the structure of COBOL


```

IDENTIFICATION DIVISION.
PROGRAM-ID. TRIANGLE.

*****
*
* COBOL SOLUTION TO THE TRIANGLE PROBLEM
*
*****

ENVIRONMENT DIVISION.

CONFIGURATION SECTION.
SOURCE-COMPUTER. IBM-370.
OBJECT-COMPUTER. IBM-370.

DATA DIVISION.
WORKING-STORAGE SECTION.

* ARRAY TO HOLD THREE INPUT VALUES.
01 TRIANGLE-SIDES.
   03 LENGTH-OF-SIDE PIC 9(9) COMP OCCURS 3.

* NUMBER OF SIDES (CONSTANT)
77 NO-OF-SIDES PIC 9 VALUE 3.

* SUBSCRIPT FOR ARRAY.
77 L-SUB PIC 9.

PROCEDURE DIVISION.

MAIN-PROCESS SECTION.
* CONTROLLING LOOPS.

   DISPLAY "ENTER THREE LENGTHS".
   PERFORM READ-NUMBER
      VARYING L-SUB FROM 1 BY 1
      UNTIL L-SUB GREATER THAN NO-OF-SIDES.

   PERFORM PRINT-NUMBER
      VARYING L-SUB FROM 1 BY 1
      UNTIL L-SUB GREATER THAN NO-OF-SIDES.
   PERFORM CHECK-VALUES.
   STOP RUN.

READ-NUMBER SECTION.
* READ A NUMBER INTO THE NEXT ARRAY ELEMENT.
ACCEPT LENGTH-OF-SIDE {L-SUB}.

PRINT-NUMBER SECTION.
* PRINT THE NEXT ARRAY ELEMENT.
DISPLAY "LENGTH " L-SUB " = " LENGTH-OF-SIDE {L-SUB}.

CHECK-VALUES SECTION.
* DETERMINE TYPE OF TRIANGLE (IF ANY).
IF LENGTH-OF-SIDE (1) GREATER THAN
   (LENGTH-OF-SIDE (2) + LENGTH-OF-SIDE (3))
OR LENGTH-OF-SIDE (2) GREATER THAN
   (LENGTH-OF-SIDE (1) + LENGTH-OF-SIDE (3))
OR LENGTH-OF-SIDE (3) GREATER THAN
   (LENGTH-OF-SIDE (1) + LENGTH-OF-SIDE (2))
   DISPLAY "THIS IS NOT A TRIANGLE"
ELSE
   IF LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (2)
   AND LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (3)
      DISPLAY "THIS IS AN EQUILATERAL TRIANGLE"
   ELSE
      IF LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (2)
      OR LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (3)
      OR LENGTH-OF-SIDE (2) = LENGTH-OF-SIDE (3)
         DISPLAY "THIS IS AN ISOSCELES TRIANGLE"
      ELSE
         DISPLAY "THIS IS A SCALENE TRIANGLE".

* END OF PROGRAM TRIANGLE

```

Figure 2 - COBOL solution to the triangle problem

LENGTH-OF-SIDE is an element within TRIANGLE-SIDES. Of course, in most cases, there would be more than one element at the lower level.

The OCCURS clause specifies that there are three elements called LENGTH-OF-SIDE making up the array TRIANGLE-SIDES. I have chosen to access these using a subscript, defined later as L-SUB. It is also possible to use an index that would be defined with the array, would have a format determined by the operating system, and would allow a number of additional functions, notably a SEARCH command.

The format of the elements is determined by the PIC clause (short for PICTURE) - in this case, nine digits. COMP (short for COMPUTATIONAL) specifies a binary field. Other forms of COMPUTATIONAL field may be available, depending on the machine. For example, in IBM mainframe COBOL, COMP-3 would specify a packed field. If COMP is omitted, the field is 'display numeric' (ASCII or EBCDIC).

The combination of level numbers and PICTURE clauses allows great flexibility in describing data structures. The higher level items, known as 'group' items, can be referred to as one block. Only items at the lowest level can have a PICTURE. Group items are considered to be alphanumeric by

definition. Thus, TRIANGLE-SIDES is an alphanumeric field. You could actually assign an alpha value to it, with all the attendant fun and games, if you then tried to do anything with the numeric array elements. Of course, this facility can also be turned to an advantage.

Special facilities

There are certain level numbers which have specific meanings. I have used one here, 77, which is used for odd fields which are not part of a data structure. However, on some machines, it is more memory efficient to group all the odd data items together under an 01 level (often called ODDS-AND-SODS!).

The special level I have found most useful is 88, used to describe Boolean variables. The value of the 88-level element can be either 'TRUE' or 'FALSE', depending on the value of an associated field. These can appear anywhere in a data structure. Look at Figure 3. Assume some piece of processing is dependent on TYPE-OF-DATA having a value of 1, 3 or 5. Instead of a long winded IF statement with a couple of ORs, the statement can simply read 'IF ALLOWED-DATA-TYPE...'. This feature was designed primarily to improve readability, but I have also found it a lot easier to maintain a list of values in the DATA DI-

VISION than to rummage around in the code of the PROCEDURE DIVISION.

All data used by the program must be described in the DATA DIVISION. The data types cannot be changed during execution, and most compilers are quite hot on not allowing invalid processing (eg arithmetic on alpha fields).

Back at the problem

The PROCEDURE DIVISION

Let's get back to the current problem. For input and output, I have chosen to use DISPLAY and ACCEPT, which can be used to communicate directly with a terminal.

DISPLAY simply writes a string of literals and data elements to the screen. It is very unstructured, for example leading zeros cannot be suppressed. Other commands may be available, depending on the machine. IBM COBOL, for instance, has a verb 'EXHIBIT', which allows a more formatted layout of the values to be written.

ACCEPT reads a value from the screen into the specified data element.

The main command for structuring COBOL programs is PERFORM. This causes a SECTION to be processed. A SECTION lasts from one heading (eg PRINT-NUMBER SECTION) to the next (eg CHECK-VALUES SECTION). If you leave off the word SECTION, the name is assumed to be a paragraph heading, or label, and processing continues merrily on. This can be wonderfully difficult to spot. It is also possible

```

01 SOME-DATA.
   03 TYPE-OF-DATA PIC 9.
   88 ALLOWED-DATA-TYPE VALUES 1 3 5.
   03 NEXT-ITEM-OF-DATA PIC 9(9).
   ...

```

Figure 3 - A Boolean variable

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to PERFORM paragraphs quite legitimately, which further adds to the excitement.

PERFORM ... VARYING... allows one or more variables to be altered at each iteration until a condition becomes true. The condition is tested at the start of the loop, so that a loop may not be processed at all if the condition is true at the beginning. Any variables are incremented (or indeed decremented) after the relevant SECTION has been processed.

Not perfect after all

To my mind, the single major design fault in ANS COBOL 74 is the lack of a terminator for a conditional block of code. Look at the IF statement in Figure 2. It begins with IF, and ends, right at the very end, with a single full stop. Suppose I wanted to print out 'END OF CHECK-VALUES' before terminating the processing, but only if the triangle was valid. My sole option is to repeat that piece of code within every clause of the IF statement to find a valid triangle, as shown in Figure 4. This is not too bad if there is only one statement. If there is more, it can be infuriating. In practice, long blocks of code would be transferred to separate SECTIONS and replaced by a single PERFORM. Nevertheless, each of the relevant

```
CHECK-VALUES SECTION.
* DETERMINE TYPE OF TRIANGLE (IF ANY).
IF LENGTH-OF-SIDE (1) GREATER THAN
  (LENGTH-OF-SIDE (2) + LENGTH-OF-SIDE (3))
OR LENGTH-OF-SIDE (2) GREATER THAN
  (LENGTH-OF-SIDE (1) + LENGTH-OF-SIDE (3))
OR LENGTH-OF-SIDE (3) GREATER THAN
  (LENGTH-OF-SIDE (1) + LENGTH-OF-SIDE (2))
  DISPLAY "THIS IS NOT A TRIANGLE"
ELSE
  IF LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (2)
  AND LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (3)
    DISPLAY "THIS IS AN EQUILATERAL TRIANGLE"
    DISPLAY "END OF CHECK-VALUES"
  ELSE
    IF LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (2)
    OR LENGTH-OF-SIDE (1) = LENGTH-OF-SIDE (3)
    OR LENGTH-OF-SIDE (2) = LENGTH-OF-SIDE (3)
      DISPLAY "THIS IS AN ISOSCELES TRIANGLE"
      DISPLAY "END OF CHECK-VALUES"
    ELSE
      DISPLAY "THIS IS A SCALENE TRIANGLE"
      DISPLAY "END OF CHECK-VALUES".
```

Figure 4 - An alternative IF statement for program TRIANGLE

SECTIONS would have to contain that repeated code.

Conclusion

A remark by one of my university lecturers concerning FORTRAN could also be applied to COBOL: 'It has grown like a weed'. I do remember finding COBOL horribly long-winded and rather archaic when I began using it. Like many another, I got used to it. Also, as with most languages I have encountered, it is fine if you use it for what it was designed for. The question as to why lan-

guages are used for inappropriate applications might make a good subject for a doctoral thesis.

EXE

After doing a degree in French and Computer Science, Christina Wheeler worked for seven years as a COBOL programmer, mostly in maintenance and support. For the last five years, she has been doing other DP related work, including training poor unsuspecting graduates in the mysteries of COBOL.



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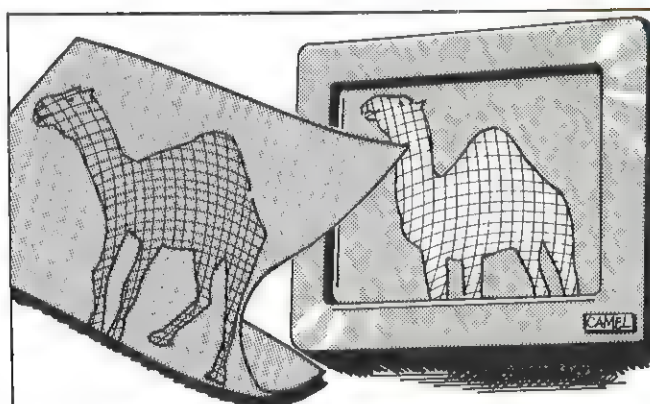
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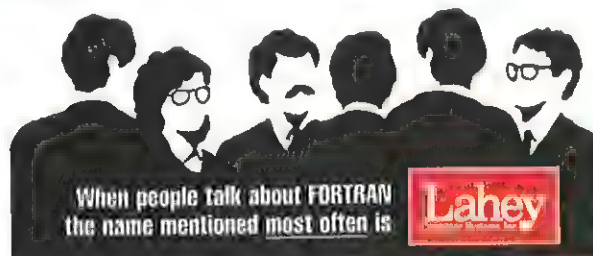
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A little Hashing

*Hashing is a simple and fast method for storing and retrieving data.
Ray Jones shows how it's done.*

Applications requiring the storage and subsequent retrieval of data are countless; from the symbol tables generated by assemblers and compilers for keeping track of variable names, through simple card files and directories, to full-blown databases.

Small stores, consisting of only a handful of data, can be built and searched sequentially without serious impact on the efficiency of the application. However, as table sizes get bigger, more sophisticated methods must be employed. This is in order to maintain reasonable response times for database queries and to ensure fast compile or assembly times.

The use of Hash Tables is one such method. Hashing techniques provide a way of quickly storing and retrieving data records. The method may be used for both large and small applications; the one that I shall present here is quite simple, although the technique is useful for many, more serious, applications.

As all database aficionados know, data records are usually stored and retrieved by means of a key field. In the case of a compiler symbol table this would be the symbol's name; other data would be stored along with this, perhaps the symbol's address and its type. It would be a neat trick, then, if the key field could be translated directly into an index which would allow direct access to the data in an array. This could save a great deal of time and effort in searching for the data.

Furthermore, given that the key field is unique, (and it should be - two variables with the same name and in the same symbol table would not be very useful) this is theoretically possible.

Index problems

Using the compiler symbol table as an example once more; each symbolic name

(represented as a string) could be treated as an integer. The trouble is that a variable called, say, 'state table' represents rather a large (11 byte) integer. The table required to accommodate such an index would need to be phenomenally big (around 3 million elements) and the redundancy, for most practical purposes, would be ridiculous. This example is, of course, ludicrously naïve, but the point remains that the formulation of a unique index of a reasonable size from an arbitrary string is not practical.

But a non-unique index will do. What if we give up trying to find a unique index from our string and make do with one that is not quite so special? Here's the plan: we have an array that is big enough to hold all the records that we will need to store, and we also have a formula into which we put the key field string and which will give us a pretty-damned-special (but not actually unique) index. We use our index to place our data into the array, or, of course, to retrieve it. And of course, we must ensure that the index is not larger than the size of the array.

What it's about

To illustrate this idea I'm going to develop a simple database program: a personal telephone directory. This is not intended to be a serious application, but could be tailored to be part of something larger and more sophisticated. The program will have two functions: the first, to allow a name and number to be added to the directory; and the second to display the number of a specified name that is contained in the directory. Neither name nor number will have any special format, they will be simple strings. Since we have to supply a number to match a name (and not vice versa) the name string will be the key field.

Sorry, wrong number

As I mentioned before, the index generated for any name will not be unique. So what

happens if the same index is generated more than once? For example, the string "Ray Jones", is an anagram of "Jason Rey" (which is a name that I must bear in mind if I ever resort to writing romantic fiction). So any function used to produce an index that takes only the single characters of the string into account (eg XORing or adding the ASCII codes) will generate duplicate indices for the two names. In the jargon, there will be a collision.

Collisions are dealt with in two ways, by choosing a function that produces few duplications and, more importantly, by providing a mechanism that will allow the potential duplications to be handled.

There are many functions that can be used to provide an index; I have adopted the simple one of adding ASCII codes quite successfully in a real application (anagrams are not that common). An enhancement to this technique would be to modify each character code, using its position in the string, before adding. This could be achieved by rotating the value a number of times that corresponds to its position in the string, or by multiplying it by that number. The possibilities are endless but space is finite, so I think I'll stop here.

Given an array of a reasonable size, collisions need not be that common, but insurance against them is compulsory.

Insurance

I'm going to supply two basic strategies for dealing with collisions.

The first is to have a secondary data structure behind each location of the primary data table. When there is a collision, each of the entries is placed in this secondary store - this may be a linked list or similar structure - and when a query results in an access to this location, the list is sequentially searched until the correct item is

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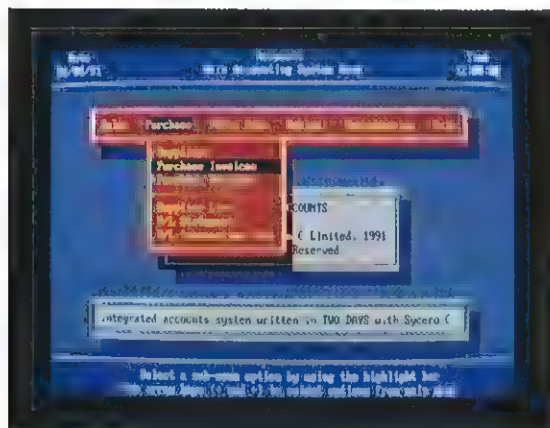


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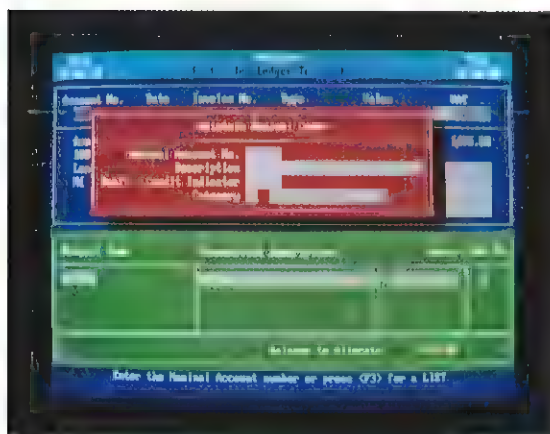
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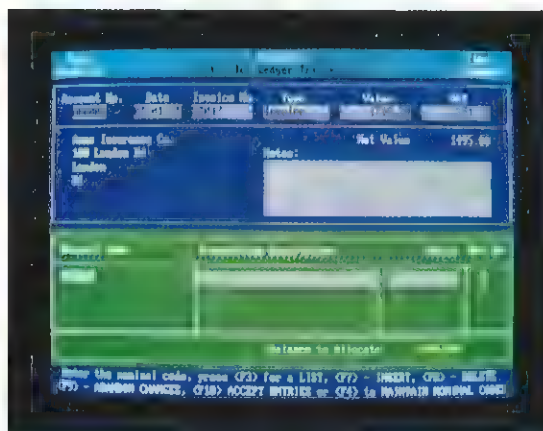
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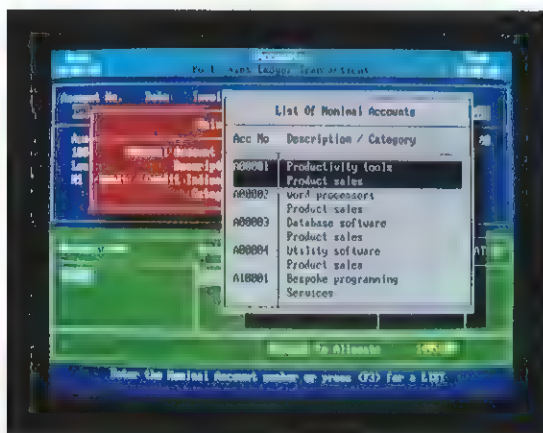
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found. Since the list is likely to be very very short - hopefully no bigger than two - there is no great penalty in implementing this search.

The second method makes use of a circular storage structure. It is very convenient to regard the data table as being circular, this allows the index function to incorporate a modulo n division (where the locations in the table are in the range 0 to $n-1$), thus tailoring the final index to the size of the table. When a collision occurs, another integer can be calculated and this used as a 'step' value to move to a new position in the table. If the second position is also found to be occupied then the same step value can be used to go to another position and so on, until a free position is found. In this way a free position will always be found unless the table is completely full. Or will it?

This technique depends on two factors, the first is that the step value must never immediately return to the original position - it must lie between 1 and $n-1$ - and the second is that the size of the table must correspond to a primary number.

This second condition is fundamental. Since a primary number is not divisible except by one and itself, any step value will visit all the locations of the table before returning to the starting position. Hence, unless the table is completely full, an empty location is guaranteed to be found no matter how many collisions are encountered.

This assertion may not be immediately obvious but it is true. Think about what would happen if the size of the table was not prime; take a table size of 8 as an example. A step value of two would result in four

locations being repeatedly visited and the remainder ignored; a step value of four would result in repeated visits to two locations. It makes no difference from which position you start. Now try a table size of five, any step value under five will visit all locations before returning to the starting point (this can be quickly and conveniently confirmed by counting on your fingers). Note that a step value of one is a special case, this will visit all table locations before returning to the start since it visits them sequentially.

One more point about the step value; it is advisable to use a different method of calculation to that for finding the original index. There are two reasons for this: the step value must be in a slightly different range to the original index (1 to $n-1$, not 0 to $n-1$) and a different method of calculation decreases the probability that the same

```

/*****
Telephone Directory by Ray Jones 1991

An illustration of the use and
implementation of Hash Tables.
*****/

#include <stdio.h>

#define OK      1
#define NOT_OK  0

/* Table definitions and declarations */

#define TABLE_SIZE 11
#define FIELD_LENGTH 20

typedef struct
{
    char name[FIELD_LENGTH];
    char tel_no[FIELD_LENGTH];
} TABLE;

TABLE tel_dir[TABLE_SIZE];

/* end of table defs etc. */

/* Initialise the table with nulls */
void initialise()
{
    int i;
    for(i=0; i<TABLE_SIZE; i++)
        tel_dir[i].name[0] = '\0';
}

/* Hashing function
- add char values */
int hash(s)
char * s;
{
    char * p;
    int hash_code = 0;
    for(p = s; *p != '\0'; p++)
        hash_code += *p;

    /* Return index value in
    range 0 to TABLE_SIZE-1*/
    return (hash_code%TABLE_SIZE);
}

/* Calculate step value
- add alternate char values */
int step(s)
char * s;
{
    char * p;
    int toggle = 0,
    step_size = 0;

    for(p = s; *p != '\0'; p++, toggle = ~toggle)
        if(toggle) step_size += *p;

    /* Return index value in
    range 1 to TABLE_SIZE-1*/
    return ((step_size%(TABLE_SIZE-1))+1);
}

/* Find a number from a name */
int dir_query()
{
    int i, h, s, attempts;
    char name[FIELD_LENGTH],
    num[FIELD_LENGTH];

    printf("\nFind an entry in the directory\n");
    printf("Please enter the name : ");
    scanf("%s", name);

    /* Calculate the hash code and step number */
    h = hash(name);
    s = step(name);

    /* Now search the table for the name */
    for(i = h, attempts = 0;
        strcmp(tel_dir[i].name, name) != 0;
        i = (i + s) % TABLE_SIZE, attempts++)
    {
        /* Check to see if all locations have
        been checked yet */
        if(attempts == TABLE_SIZE)
            return NOT_OK;
    }
}

```

Figure 1 - Telephone directory program

step will be generated for symbols that produced the same original index (thus a second collision is less likely).

Telephone Directory

Figure 1 shows a simple telephone directory program using the technique that I have described. The program is written in C and doesn't use any non-standard functions or libraries, so it should run on just about anything.

The main function first calls an initialisation routine, (this simply nulls all of the entries in the directory) and then implements a simple menu. The two major functions are `dir_add` and `dir_query`; these implement the basic functions of adding an entry to the directory and looking up a telephone number from a given name. They are very similar in function. The first searches the directory, using the hash and step functions, until a blank entry is found, and the second searches until a match is found between the given name string and that found in the name part of the array. In

both cases a check is made to see if the search has covered every location in the array; if it has, then the search is abandoned because either the table is full, or the name being searched for is not in the table.

The hashing function that generates the original index is the one I described earlier; it simply adds each of the character codes in the name string. The step function is similar but adds alternate characters. Both number are treated to a 'modulo *n*' division to bring them into the appropriate ranges.

Within each of the searching functions there are printed messages which show the locations of the array being searched. These would not of course be required in a 'real' system, but they are useful to show the operation of the hashing mechanism. Try entering a few anagrams and see what happens; with any luck, after the first collision the step value will take you to a vacant location. This becomes less likely as the number of entries grows. The array size has been defined to be deliberately small so that you can see this in action without hav-

ing to enter the entire Yellow Pages or the complete contents of your Little Black Book.

Practically Speaking

The Telephone directory program has been left deliberately simple so as not to hide the technique that I wish to illustrate with unnecessary embellishments. But if you really want to make use of it, simply change the initialisation function to read entries from a file (using the same technique as the `dir_add` function), make sure that the file is saved again on exit if there have been any changes, and change the defined table size to a number that is more useful (not forgetting that this must be prime).

EXE

Ray Jones is a software engineer who specialises in the design of technical and real time software. He may be contacted by email at raja@cel.co.uk, or raja@uk.co.cel, depending on which your mailer likes best.

```

    printf("Trying location %d\n",i);
}

printf("Name found at location %d \n",i);

/* Found name so print number */
printf("The number for %s is %s\n",
       name,tel_dir[i].tel_no);

return OK;
}

/* Add a name and number to the directory */
int dir_add()
{
    int i,h,s, attempts;
    char new_name[FIELD_LENGTH],
          new_num[FIELD_LENGTH];

    printf("\nAdd an entry to the directory\n");
    printf("Please enter the name : ");
    scanf("%s",new_name);
    printf("and now the number : ");
    scanf("%s",new_num);

    /* Calculate the hash code and step number */
    h = hash(new_name);
    s = step(new_name);

    /* Now search the table for a vacant position */
    for(i = h, attempts = 0;
        tel_dir[i].name[0] != '\0';
        i = (i += s) % TABLE_SIZE, attempts++)
    {
        /* Check to see if all locations have
           been checked yet */
        if(attempts == TABLE_SIZE)
            return NOT_OK;

        printf("Trying location %d\n",i);
    }

    printf("Free location found %d \n",i);

    /* Found a vacant position so copy in the
       new name and number */
    strcpy(tel_dir[i].name,new_name);
    strcpy(tel_dir[i].tel_no,new_num);

    return OK;
}

/* Main loop and menu */
void main()
{
    char c[2];

    initialise();

    for(;;)
    {
        printf("\nQuery, Add or Exit? (Q,A,X):");
        scanf("%s",c);
        switch(toupper(c[0]))
        {
            case 'Q':
                if(!dir_query())
                    printf("\nName not in directory\n");
                break;
            case 'A':
                if(dir_add())
                    printf("\nNew name entered OK\n");
                else
                    printf("\nNew name not entered -\n
table full\n");
                break;
            case 'X':
                printf("\nBye for now.\n\n");
                exit(0);
            default:
                printf("\nInvalid selection\n");
                printf("Please press one of [Q,A,X]\n");
        }
    }
}

```

Figure 1 - Telephone directory program (Continued)

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d C:\ USER+ *C
d \ *V+ *C
d \ *S+R+C+L+ *C
d *S f
d max=2M min=50k
d on=-7
d after=-365 before=-3
d after=-10-12-90
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POSIX - consider it standard

*What is POSIX? What is it for? How does it differ from UNIX?
Here is Peter Collinson on a much-misunderstood standard.*

Someone from a local council rang me up the other day saying 'I've read your articles in *.EXE* and wondered where I could get copies of the POSIX standards document from?' This was interesting because in the last few months I have become involved with the IEEE efforts in standardising UNIX and creating the POSIX standards. Some of the time I am working for the US UNIX User group, Usenix, as their Standard's Liaison. I guess that the magic word 'POSIX' is beginning to appear on system purchase specifications.

The Institute of Electrical and Electronics Engineers (IEEE) is a US group that has been involved with the generation of many standards. The standardisation work that sprang from UNIX is more usually known as POSIX, the Portable Operating System. There are a couple of common misconceptions. First, the standards do not define UNIX, they define POSIX. One way to think of this is that POSIX is a generalisation of UNIX. Many UNIX systems are POSIX compliant and it's quite likely that other systems with different names will also measure up to the standard.

Second, it's not a single standard. It's a group of about twenty standards; or it will be, because only two have reached the end of the process. It's a group of standards because of history. When the IEEE established the controlling committee for POSIX in 1985, the work was labelled project 1003, or P1003. This quickly split into two, P1003.1 for the operating system interface and P1003.2 for the shells and utilities. It is current practice to replace the 'P1003' by 'POSIX', so the original projects are known as POSIX.1 and POSIX.2. There are now around 20 active projects, and knowing which 'dot' number relates to which activity has become an expert subject suitable for Mastermind questions.

What most people think of as 'POSIX' is actually 'POSIX.1'. This defines a set of rou-

tines that may or may not be system calls. They specify the system interface, the interface that applications use to make things happen in the outside world. POSIX.1 is now an international standard, printed on A4 paper rather than quarto, with a new grand international number. The standard is: ISO/IEC 9945-1: 1990, Information Technology - Portable Operating System Interface (POSIX) - Part 1: System Application Program Interface (API) [C language]. The 'C language' in brackets means that the standard is expressed in a specific language - yes, C. ISO would much prefer this to be independent of any language and work is under way to do just that.

The second project, POSIX.2 (shells and utilities) has not managed to generate a full standard yet, but it is close. A third project, POSIX.3, produced a standard in April of this year. It's called 'Test Methods for measuring Conformance with POSIX' and 'defines general rules for developing test assertions and related test methods for measuring conformance of an implementation to POSIX standards'. The standard is really aimed at the people who make test suites and the people who write standards for the testers to test. All the other projects are at different stages of development. Perhaps I will do an article on the proliferation of POSIX in a future column.

What does all this mean?

We should be seeing systems popping up that claim to be POSIX.1 compliant. Strictly they are not unless they have been tested using a verification suite that complies with POSIX.3, but this will take a little time to filter in.

As (and if) POSIX systems become more widespread it should mean that programs written on one system should transfer trivially to another. To ensure that this can happen you will have to make sure that

your program is written to the POSIX.1 standard - POSIX makes no guarantee unless you follow all the rules. The goal in all this has never been binary portability, but the ability to move source from one system to another, compile it and go.

One effect that I am hoping to see is the widespread adoption of the ANSI C standard. Standards-makers like to base their standards on other definitions, and POSIX is no exception. It has taken the ANSI C language definition and routine set as a basis for moving forward. If a system is POSIX compliant, then it should offer ANSI C.

It has been annoying to see the push to sell new things arm the DOS world with ANSI C, when many UNIX systems are still supplied with C compilers based on the old pcc compiler (or variants of it). I want the common base of everyone to be ANSI C, so that this eliminates any fear of non-portability when you write code for someone else. To achieve this, everyone buying a new UNIX system must be *given* an ANSI C compiler.

Basically, I want to write in ANSI C without all the disgusting ruses needed to make the C-preprocessor remove the function specs so that things will compile on old C compilers. If I am to write in ANSI C, I want it to be widespread so that everybody who has a C compiler can compile my programs. I am hoping that POSIX has this effect at least.

Changes to the system

POSIX.1 started life as a codification of UNIX System III and then System V. It also has had significant input from the Berkeley world. POSIX.1 does genuinely attempt to join both the System V and BSD worlds and is stronger by taking the experience from both camps. This makes things a little hard for System V, because it has always guaranteed backwards compatibility. A number of

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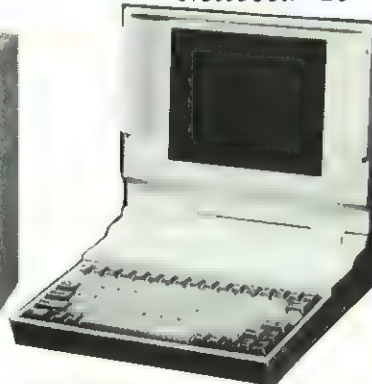
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decisions in the system design have been coloured by that need.

The first change to the System V view of the world is in the area of signals. A signal is an event sent to a process to indicate that something unexpected has happened. This is perhaps floating point overflow from the hardware; or the user has typed the interrupt key and wants to stop the current process running. The interrupt key is often Control-C, but it can be changed by the user. UNIX gives you a well defined mechanism for handling these events.

A process running on UNIX chooses what to do when signals are received. First, it can ignore their existence and leave them set to their default values. The default action that is taken depends on the nature of the signal; mostly the process will die. Most programs do this. Second, the process can take action to ignore the signal completely.

Finally, the process can arrange to catch the signal. This means that a routine is nominated to be called when the signal occurs. The UNIX program will say:

```
int func();
signal(SIGINT, func);
```

This makes the program call the `func()` routine when the SIGINT signal is received. SIGINT is the signal that is sent when the user hits the interrupt key.

The program merrily pursues its course until the user strikes the interrupt key. The system arranges that the routine `func()` is entered and does the stuff that the user wants. Exit from `func()` will make the process resume execution from where it was rudely interrupted.

However, most catching routines do some work and then exit from the process. The signal has been caught to tidy up the world a little before exiting. Commonly, the process has created some temporary files and a good programmer will want to delete them, being a responsible citizen, before the process finally dies.

Signals started life aimed at the tidy-up application but began to be used as a means of interprocess communication. A program that placed something in a line printer queue would send a signal to the background process to say 'wake up, there's work to do'. It was then that a snag was found in the way that signals had been defined.

The original systems said that when a signal had been taken, the action of the signal reverted to the default. The catcher routine would be called, and would need to reset

the action of the signal back to program control. Signal catching routines contained code like:

```
func()
{
    signal(SIGINT, func);
    ....
}
```

to reset the signal handler when the signal occurred, or perhaps

```
func()
{
    signal(SIGINT, SIG_IGN);
    ....
}
```

to ignore the signal until later.

The problem is that there is a finite time *after* the first signal was received before the `signal` routine can be called to reset things. In the interim, the action of the signal is set to the default: sudden death. So a second signal can arrive quickly after the first and the process is killed because it has not had sufficient time to reset the signal handler.

POSIX.1 has adopted a solution from 4.3BSD that allows signals to be treated very much like traditional interrupts. Signal handlers are permanently installed. Signals can be blocked from delivery by use of a *signal* mask. A process also has a set of pending signals. These include any signals that might have been generated but are currently blocked from delivery. If a signal occurs that is blocked, it is added to the set of currently pending signals.

A process can set the mask at any time and can also specify what the mask should be set to when a signal happens. The signal handler can be entered with the default masking state of the signals already established.

The result of all this is to make signals considerably more predictable and it is now possible to write event driven programs where events are triggered by signals.

Job Control

Signals are probably the area of greatest change from the System V view of what UNIX should be. Another is the implementation of 'job control'. Unfortunately this is optional so you will still be able to get POSIX compliant UNIX systems without job control. I won't be buying them.

The idea of job control is that a user can type a key and temporarily stop the current command line from running. Since the command line can be a collection of processes, the word 'job' is used to mean 'the set of processes that constitute a single task'. Of course, this is most often just a single process. To get a flavour of job con-

trol in action, let's think what happens when you are compiling a huge C program:

```
cc -O -o huge huge.c
```

and the boss walks in to ask a question. The question means that you need to look at something on the computer. If you don't have windows or separate pseudo terminals then you are in a quandary. Do you kill the compilation to answer the question? Has it nearly finished? Can you keep the boss talking long enough? All these thoughts rush through your brain as you reach for the interrupt key to kill the compilation.

With job control you simply type Control-Z to suspend the job and then use the `bg` command to continue the job running in the background. With `csh` it looks like:

```
% cc -O -o huge huge.c
^Z
Stopped
% bg
[1] cc -O -o huge huge.c &
%
```

The sequence allows you to move a command from the foreground to the background so it can continue executing leaving the foreground free for other things. In this case answering that stupid question (calm, calm). When the boss leaves, you can move the job into the foreground by saying

```
% fg
cc -O -o huge huge.c
```

the shell will reprint the command and move it into the foreground.

There are several reasons why this approach works well. The first is that I can suspend the current job without planning ahead. I don't have to worry about creating a new window. I don't have to have already created a pseudo-terminal or shell layer. I just simply type Control-Z and get on with things.

Secondly, it's based on signals. As I have described above, signals can be caught. When I suspend a job that controls the whole screen (like a visual editor) I can catch the signal and make the process redraw the screen when it resumes.

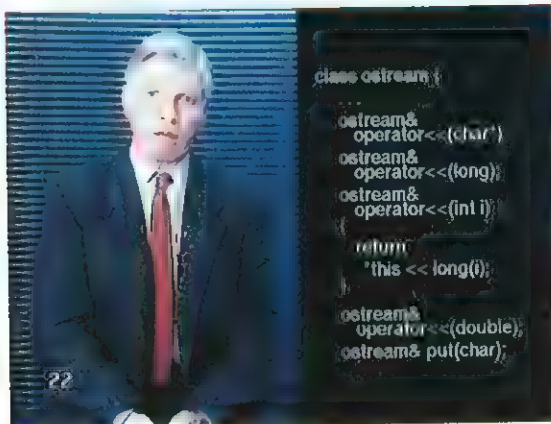
This system is just great and I use it all the time, even though I now have a workstation and the ability to have multiple terminals on the same screen. It will not affect your application program but the application programmer will like it.

More reading

I have picked on perhaps the two most interesting areas to highlight. I should also warn BSD programmers that they are going to need to alter their ideas of how to control

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terminals. The System V terminal interface is now standard (there are some slight changes). It's very hard in a small article to cover what the changes will mean to a programmer. If you feel that POSIX will affect you then you can find some further reading.

The standard itself, 'ISO/IEC 9945-1: 1990, Information Technology - Portable Operating System Interface (POSIX) - Part 1: System Application Program Interface (API) [C language]' is published by the IEEE and available from them in the US. It is available in the UK from ILI (London Information) phone 0344 23377. You must ask for P1003-1990 and you will get a price of £58. They will charge £103 if you ask for ISO/IEC 9945-1 (strange). The document is expensive. It's also a little impenetrable since it's designed to specify something rather than teach you how to use it. It does have two sections, the first is the standard itself and the second the rationale behind many of the features. These are numbered together so if you want to look up the rationale behind section 7.2.4 you look this up in B7.2.4.

Then there is a book in the Nutshell series from O'Reilly & Associates. The book is 'POSIX Programmer's Guide' by Donald Le-

wine. Its ISBN is 0-937175-73-0. The book is distributed in the UK by Addison-Wesley.

The book is split into two sections, the first third contains ten chapters of discussion. This is followed by 300 pages containing the description of the library functions that a programmer will use. The second part of the book is done well, and will be very useful as a reference guide. I especially liked the addition of references to the standards on each 'manual' page. There are several appendices and a comprehensive index.

I think that the first section of the book is adequate but very thin in many places. For example, the chapter on processes has a lot of discussion on the system calls that exist and only a small amount giving the why and the how. The book avoids much mention of job control, this is relegated to a couple of pages at the end of the chapter on terminals. The book really fails when things get more 'technical'. However, it is well written and is easy to read.

The final book is along the same lines as the last. This is 'The POSIX.1 Standard, A Programmer's guide' by Fred Zlotnick. This is published by Benjamin/Cummings, ISBN

0-8053-9605-5, and is also distributed in the UK by Addison-Wesley.

This book is much more complete from a technical point of view. It gives a lot more background and explanation of why decisions were taken, it does more comparison with existing reference systems (System V.3 and 4.3BSD). I like the way that every routine specification is shown with any associated header files.

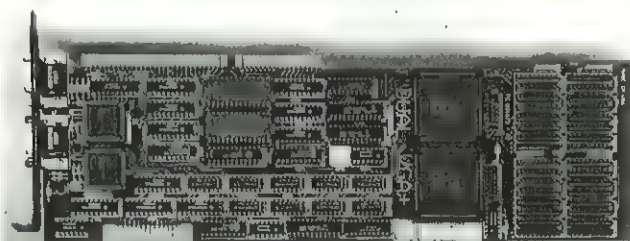
I much prefer Zlotnick's book - it seems more complete and contains more information. It is much denser, and possibly harder to read. However, the reference material is not as good as Lewine's book and I would guess that if I started programming to the standard then Lewine's book would lie about the desk being used as reference material. I am pleased to have both books.

EXE

Peter Collinson is a freelance consultant specialising in UNIX. He can be reached electronically as pc@hillside.co.uk (although your mailer might be happier to put the address the other way round) or by phone on 0227 761824.

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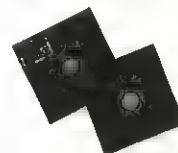
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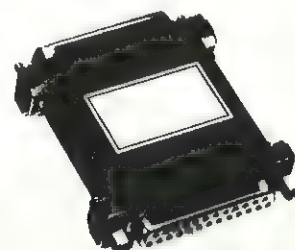
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Windows for Who?

Windows 3 Power Tools. Crikey, I never thought I'd need a GUI to use my Black and Decker. This tome is dedicated to a breed of Windows junkies known as 'Power Users'. These people apparently just can't keep their hands off the thing and are thirsting for every last drop of info about how to muck about with it. It is not designed for Windows programmers but rather for experienced Windows (and computer) users. There are 17 chapters in the book, the first 13 dealing with tips and techniques for fine-tuning the operating environment. The last four chapters are concerned with the software that comes on a diskette with the book.

The main text of the book can be divided into two categories: statements of the glaringly obvious; and the bits that might be useful. For instance, the chapters on Program Manager and File Manager Techniques don't appear to tell you much you couldn't glean from dipping into the Windows manual. The chapters on printing, configuration, and sharing data between applications may contain some tips that these power users are not aware of, but I don't know. The problem is, you see, that I'm not quite sure what the people this book is written for actually get up to. One gets the impression that they must be closet boffins masquerading as businessmen. The level of expertise assumed in the reader vacillates wildly. Topics covered range from discussions about Windows memory management and extended memory drivers to how you arrange icons in the program manager. Consequently the snippets of handy information are embedded in a lot of turgid waffle.

The disk that is supplied with the book contains four applications that allow you to further customise (ie tamper with) your generic copy of Windows 3. These are: *Oriel*, a graphics-based batch language that lets you build your own Windows apps; *Command Post*, a character-based replacement for the File Manager (what's the point?); *Aporia*, an 'object-oriented' (I use the term loosely) graphical shell for Windows; and *IconDraw*, an icon drawing program that lets you design your own custom icons for applications (whoopee). As far as I can make out, none of these are of any use and would, if installed, utterly confuse anybody else who jumped on your machine. Surely, one of the main benefits of using something like Windows is that the shell presents a consistent system view to any user. I have no doubt that the programs are well written and very clever but I do question their *raison d'être*.

Windows 3 Power Users, come out, come out, wherever you are! This book may be the one for you, but somehow I think not.

Title: *Windows 3 Power Tools*
Authors: Geoffrey T. LeBlond, William B. LeBlond and Jennifer L. Palonus
Publisher: Bantam Computer Books
Price: £46.99
Pages: 664
ISBN: 0-553-35298-9

A Tale of One Processor

Has the segmented architecture finally taken a toll on your sanity? Motorola has been producing the 68000 since 1979 and offers a genuine alternative to Intel's 80x86 family of microprocessors. Speaking as a born and bred MS-DOS programmer, reviewing a book on the 68000 seemed like the most appropriate way to acquire a genuine insight into the fundamentals behind this processor.

MC68000 Assembly Language Programming is intended as an introduction to assembly language programming for first year Computer Science students and assumes the knowledge of a high-level language like Pascal or Modula-2. Each chapter may be treated independently and aims to give the reader a thorough understanding of the 68000 repertoire, ending with a set of exercises; luckily for the discerning student, Appendix G contains a set of answers. On closer examination, it would seem that some of the questions given tend to be rather monotonous. Don't be surprised if you are asked to rewrite a previous exercise using a different addressing mode or using a new instruction. Adding a little variety would have certainly been more entertaining.

There are frequent reviews of what has been introduced so far and this provides a painless method of determining which subsection contains information on a particular subject. With the evidence given so far, you may be under the impression that *MC68000 Assembly Language Programming* is purely a tutorial guide for delinquent Computer Science students, but there is more. The complete 68000 instruction set is covered in detail, together with numerous example programs. There are even chapters devoted to programming the main peripheral devices in the Motorola family. These are presented in the format of a technical data sheet and contain example code. Both polling and interrupt driven I/O are given adequate coverage.

As a passing observation, you should be warned that the examples in these chapters tend to be annoyingly similar. For instance, you are not only subjected to serial I/O on two functionally similar devices (the MC6850 ACIA and the MC68681 DUART) but identical examples using both polled and interrupt driven serial I/O are also given. Most of the example programs are written for a number of single board computers but I am sure that it is not too difficult to adapt the code to run on your STs, Amigas or Macs. For the owners of such machines *MC68000 Assembly Language Programming* provides an adequate reference covering the programming of the 68000 microprocessor and its peripherals, whereas anyone wishing to learn 68000 assembler would do well to consider this offering in terms of its tutorial benefits.

Title: *MC68000 Assembly Language Programming*
Authors: Brian Bramer & Susan Bramer
Publisher: Edward Arnold
Price: £16.95
Pages: 344
ISBN: 0-340-544-51-1

Books Received This Month

<i>Object Oriented Assembly Language</i> by Len Dorfman	Windcrest	£18.95	ISBN:0-8306-7620-1	pp360
<i>A New Guide To Artificial Intelligence</i> by Derek Partridge	Albex	£19.95	ISBN:0-89391-608-0	pp546
<i>Novell Netware PowerTools</i> by R J Palonus	Bantam	£46.99	ISBN:0-553-35298-9	pp664
<i>LOGIC - A Foundation For Computer Science</i> by V Spersneider and G Antoniou	Addison Wesley	£21.95	ISBN:0-201-56514-5	pp495

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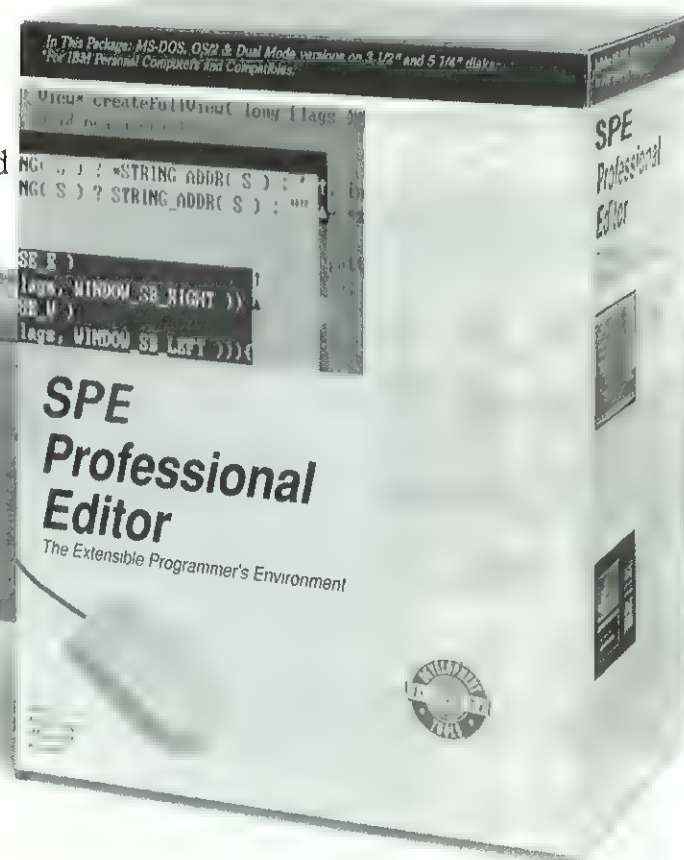
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[Will]

The Editorial Team of .EXE wishes to make A CALL FOR PAPERS [A request for articles]

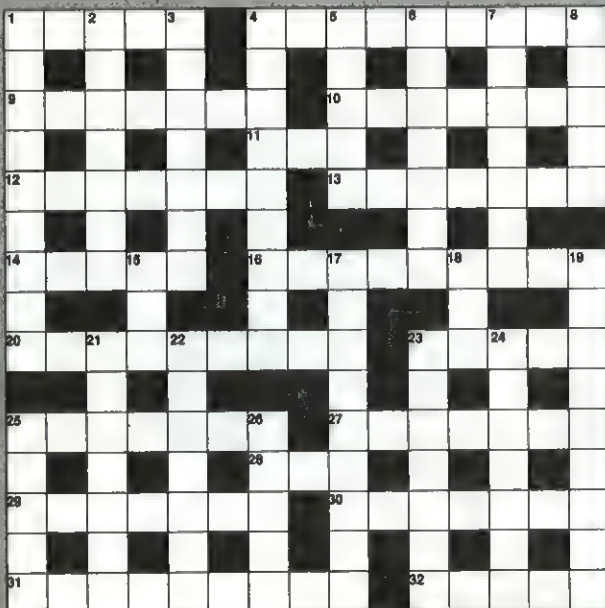
Forthcoming Editorial Thematic Issues:
[Topics coming up] October - Mostly UNIX
 November - GUI's
 December - Back to the Future

Other ideas always welcome
*[ie the lazy s*x'd can't think of them himself]*

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Contact The Editor, .EXE Magazine, 10 Barley Mow Passage, London W4 4PH

AUGUST .EXEWORD



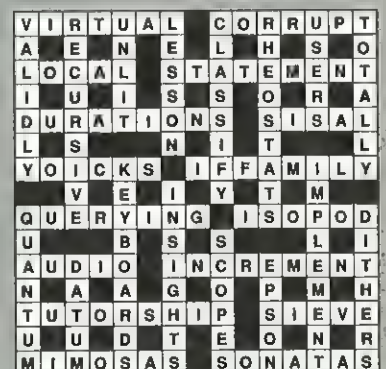
ACROSS

- 1 Provide a running check on the first track event (5)
- 4 Identify the characteristic... (9)
- 9 ... to the goose: bend over, it's George's (7)
- 10 Parboli sort of transistor (7)
- 11 Wise bird to produce *guide* (3)
- 12 Hidden time to lay round ten hundred (7)
- 13 Sweets in European dens... (7)
- 14 ... of harmonic water flow ... (5)

- 16 ... in peace with infinite snr (9)
- 20 26 sets of stolen goods? (9)
- 23 Use silver about the orient as labels and data types must (5)
- 25 Extension socket or adc (7)
- 27 Employer action leads to fatal crash (7)
- 28 Palendromic language from a countess (3)
- 29 Person (not young) was in charge (7)
- 30 It follows you in France with a charge for guidance (7)
- 31 Madly happy when heated (9)
- 32 Keen sign of hesitation about some time (5)

DOWN

- 1 Hollerithian hardware ... (9)
- 2 ... stopped running right at the start? (7)
- 3 Global constant time-wise (7)
- 4 Pain in the neck on any cane strangely (9)
- 5 It may hold labels when output by 1dn (5)
- 6 I am brief digital unit with brief effect (7)
- 7 Madly rile guy with nasty temper (4,3)
- 8 Gets financial input from broken snare (5)
- 15 Cut part of a lax executive program (3)
- 17 How the wire's sheath acts (9)
- 18 Lump of wood holds run-time record (3)
- 19 Bribe that coats the pill? (9)
- 21 Data path tunnelled under (7)
- 22 Wholly unreal value (7)
- 23 In the bow I have long term data store (7)
- 24 In support digging at the bottom of the tree (7)
- 25 Bearing weapons in a disturbed dream (5)
- 26 Telecomms system with 57 degrees (2 in binary) (5)



JULY .EXEWORD

'.EXEWORD' compiled by Eric Deeson

City**£ Excellent**

Developing substantial delivery systems for brokerage and dealing rooms, based on OS/2, Presentation Manager and Token-ring LAN's. Our client requires OS/2 PM programming, OS/2 kernel programming and Microsoft C. Any of the following are useful: MS-Windows, NetBIOS, X.25, SDLC, Async, MS-DOS, PVCS, UNIX, Stratus VOS, Oracle, Sybase or Ingres.

Wilts**to £24k**

Leading Software developers seeking additional staff with C/UNIX skills combined with one of: X-Windows, MS-Windows or C++.

Holland**£ neg**

Leading Chemicals organisation needs two individuals in their Process Control department:

- a) Software Engineer with C/UNIX skills.
- b) UNIX and VMS System Support.

E. Anglia**to £25k**

Major R&D development program requires at least 2:1 graduates with experience in some of the following: C, UNIX, Real-Time, Neural Networks, C++, Voice Recognition, Speech Synthesis, OOD, DSP, OSI/X.25.

Surrey**£17k - £21k**

Premier developer of graphical databases on Sun and AppleMac is seeking two individuals: one with good UNIX/C, the other with AppleMac experience. Any IBM PC or Postscript.

Hants**to £20k**

Leader of an ISDN Esprit 11 project consortium is seeking a software engineer with experience of X.25 development under C and UNIX. Benefits include 10% non-contributory pension.

Herts**to £23k**

3D graphics tool developer for various workstations is seeking UNIX and C skills with one of the following: C++, Fortran or CAD. Excellent promotion prospects

Herts**£ Good**

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MANY OTHER OPPORTUNITIES TOO NUMEROUS TO MENTION - SO FOR FURTHER DETAILS CONTACT ANTONY BRIDGE EITHER BY PHONE OR IN WRITING.

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Software Installation**Berks****£20-£25k**

Not really a software job, but we ideally want a graduate with a Technical Support background, primarily in MVS, but different platforms are an advantage. This position is a combination of software installation, technical support and capacity planning, with a very large Multi-National Corporation.

Ingres/Oracle/Sybase**London****£20k neg on exp**

One, two or even all of the above? Two or three years experience? We are looking for people with a good background, preferably from a major software house. You will have had experience in large projects and SSADM. There are a number of positions we can offer you, all within established consultancies / system houses.

Oracle/Technical Services**London****£20-£25k (+car)**

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Windows/C/Securities knowledge**London****£20k neg on exp**

Either PC or UNIX platform knowledge, and some database experience would be an advantage for this C/Windows development role. The essential requirement is for experience in the securities field, to work on in-house systems for this securities house.

PC/Network Support**London****£16k**

Energetic, friendly support professionals needed to do exciting work running the PC network at this large enduser site. In addition to all the hardware and software support, the responsibilities will include further development and expansion of the existing systems and more installations. Interested...?

Junior Coder**Dorking****£13.5 up**

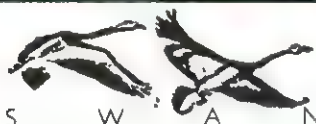
C - UNIX - Windows - Oracle, some Mac Interfacing would also be of interest. An ideal position for a recent graduate with just a little commercial experience.

Junior Coder**Berkhamsted****£13.5k up**

C - Windows - 4GL & SQL types of skills, one year experience upwards, rewarding software project....

Software Developer**London****£19k**

C - Assembler - LAN - Real time and VGA card skills? This project is a good one, with excellent team structure and competent management. Good hardware expertise and structured techniques would be a bonus.

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Ref: TM

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industrial networks (eg ARCNET) or embedded kernels (eg OS-9) would be advantageous.

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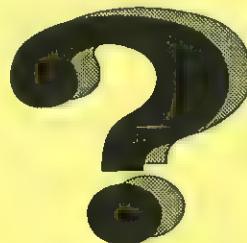
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The Candidate

You have a minimum of 3 years' experience with 'C' and UNIX, and ideally some related skills including X-Windows, MS-Windows, SQL databases, 4GL's and graphics. You recognise the potential of career development within an exciting and rapidly expanding Company, and have the initiative to exploit that potential.

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Location: The City and Home Counties

Ref: PCEX10/1

OS/2 Presentation Manager **£20-25,000**

This City based software house specialises in providing systems for the Securities industry. They are currently undergoing a major growth phase and amongst their vacancies is the requirement for someone to join a small team developing and supporting an Information Delivery System based on a networked *OS/2* environment. You will be responsible for all Presentation Manager development and support, and you should have at least two years experience of *Presentation Manager* programming, together with strong *Microsoft 'C'* skills. An MS-*Windows* version is planned for the future, so exposure to, or interest in, *Windows v.3* development would be useful. This is a high profile role with opportunities to progress into 'Hands-on' management therefore rewards will be significant, whilst dependent on experience.

Ref: PCEX10/2

'C' Developer **£18-24,000**

This young, dynamic company develop advanced software solutions for the international dealing room environment. They are now looking to recruit an analyst/Programmer educated to degree level and with 2-3 years real-time '*C*' development experience under *DOS* or *OS/2*. Preferred skills also include knowledge of communications and/or datafeeds, real-time financial information systems and relational database experience, particularly *SYBASE*. The team environment is enthusiastic and proactive and all future employees must possess good interpersonal and customer liaison skills as well as a smart appearance and enthusiastic approach.

Location: City

Ref: PCEX10/3

Real-Time Unix & 'C' **to £25,000 + Benefits**

Due to its continuing success, this leading supplier of real-time systems to financial institutions across the world is currently looking to expand its development division based in Central London. A number of positions are available for software engineers with a minimum of 2 years experience, as well as consultants with over 4 years experience. It is essential that all candidates have experience of a real-time programming environment coupled with one of the following: *Unix*, '*C*' and *X-Windows*. All suitable candidates will also have exposure to the complete product lifecycle. Although not essential, any knowledge of the following would be advantageous: trading room systems, *AIX*, *Ultrix* and *VMS*. The company offers excellent career development, the opportunity for work overseas and a range of benefits on top of a competitive salary.

Location: London

Ref: PCEX10/4

For further details of these and other permanent vacancies please contact Conrad Hills, quoting the relevant reference, on 071-734 4010 (office hours) or 081-542 8724 (evenings/weekends). Alternatively, write to McGregor Boyall, Lyndale House, 49-50 Great Marlborough Street, London W1V 1DB or fax your CV on 071-734 1297.

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IT HUMAN RESOURCING

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STOB - Barbara Cartland is a Compaq

'Scirocco, the software system from Hectare Ltd, is churning out a new 300-word love story every two seconds... The program can also be used for interpreting annual reports and accounts, and generating parliamentary replies' - The Independent.

C:\>scirocco /love
SCIROCCO LOADING, PLEASE
WAIT...

The phone rang loudly, breaking into her thoughts. Would it be John? Would he still want to go to Corfu with her? Despite herself, her hands trembled as she picked up the phone.

'Yes?'

'Is that you, darling?' His dear voice boomed in her ear.

'Oh yes, darling!' Her hands were trembling on the receiver.

'Did you have a good day?' boomed out his dear voice.

'Not bad. How was yours?' she replied, trembling.

'It wasn't bad ^C

', he boo ^C

USER BREAK

C:\>scirocco /finance
SCIROCCO LOADING, PLEASE
WAIT...

The phone rang loudly, breaking into her thoughts. Would it be John?

'Yes?'

'Hello Jane. The report has finally come through.'

'Well?'

'They're going in. Twenty-seven million fully paid up, retrospective option voting shares.'

'Twenty-seven million? But what about the tax liability?' She trembled at the thought.

'Tax liability?' he boomed.

'Tax lia ^C

USER BREAK

C:\>scirocco /parliament
SCIROCCO LOADING, PLEASE
WAIT...

The phone rang loudly, breaking into her thoughts. Would it be John?

'Is that you John?'

'Before I answer that question, I would like to state categorically, emphatically and clearly that the question of identity is...'

She interrupted him, trembling.

'But John, it's me!'

'No, no; you've had your chance to speak, now it's my turn ^C

you in the so-called press ^C the right honourable member pressing against her ^C ^C ^C

USER BREAK

C:\>scirocco /love
SCIROCCO LOADING, PLEASE
WAIT...

'Oh BB', she sighed, nuzzling his shoulder, 'you're so much older and richer than me. I know our love will never fail. Why don't we get together and make an operating system?'

'Yes. Yes! We must do it!', he breathed. 'And we must call it "OS/2".'

'OS/2?' The elegant line of her brow wrinkled. 'OS/2? I thought a far better name would be Win ^C

USER BREAK

WOT?

'Are you SURE you don't want to know how it finishes? (Y/N)

EXE



PLANET
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Planet International was launched as the recruitment wing of a leading PC training company specialising in database and programming products - Delta Dimensions Ltd. Delta as an Authorised Training Centre for many leading software houses, such as Nantucket, Fox Software International, Ashton-Tate and Lotus, enables Planet International to make full use of the considerable technical expertise at hand, to place quality candidates in appropriate positions.

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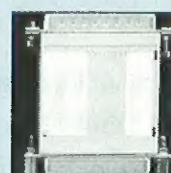
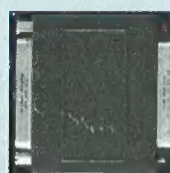
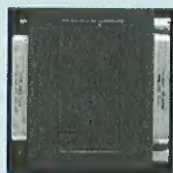
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